WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Interim Guidelines For Compost Quality

Washington State Department of Ecology
Solid Waste Services Program
Publication #94-38
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Revised November 1994

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Interim Guidelines For Compost Quality

Prepared by:
Marnie Tyler
Steve Diddy
Joy St. Germain
Stewart Lombard
David Nightingale

Solid Waste Services Program
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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. Box 47600 • Olympia, Washington 98504-7600 • (206) 407-6000 • TDD Only (Hearing Impaired) (206) 407-6006

November 30, 1994

Compost Quality Guideline User:

The enclosed Interim Guidelines for Compost Quality were prepared to provide a compost product quality baseline in Washington state. Ecology recognized the need for a compost quality baseline when an increasing number of solid waste plans and facilities began using composting to reach waste reduction and recycling goals.

This version of the Interim Guidelines for Compost Quality includes the following revisions to the April, 1994 version: changes in stability test and pathogen indicator recommendations; changes in some of the recommended compost testing methods; information from the Department of Agriculture; and a new appendix containing testing protocols for fecal coliforms.

These guidelines are not mandatory standards but rather a set of recommendations for use by composting operations and local health agencies. The Department encourages flexibility and discretion by local health departments in using the guidelines for the evaluation of safe and environmentally sound compost.

Your comments and operating results regarding these interim guidelines are encouraged and solicited. Please send them to:

Washington State Department of Ecology
Solid Waste Services
Technical and Policy Support Section
Compost Quality Comments and Results
Post Office Box 47600
Olympia, Washington 98504-7600

Your considered opinions and operating data are important. They will be used when Ecology develops the final version of this document in approximately two years. We appreciate your interest in compost quality and hope you find these guidelines informative and useful.

Sincerely,

Michael A. Wilson
Manager
Solid Waste Services Program

MW:dn:ld
Enclosure

To obtain a copy of this document, contact:

Department of Ecology
Solid Waste Services, Technical Assistance Section
P.O. Box 47600
Olympia, WA 98504-7600

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Ecology would like to recognize the many people who have participated in the external and internal review committees for all of the helpful input they have provided. The following individuals were generous in their willingness to provide their time and expertise to the previous drafts of this document. However, their opinions and views on various issues are not necessarily reflected in this document. Nonetheless, these Guidelines have certainly been improved by the efforts of each group member.

EXTERNAL REVIEW COMMITTEE MEMBERS

Dick Boose
Department of Ecology
Toxics Cleanup

Kyle Dorsey
Department of Ecology
Solid Waste Services Program

Steward Lombard
Department of Ecology
Manchester Lab

Jim Pendowski
Department of Ecology
Solid Waste Services Program

Wayne Turnberg
Department of Ecology
Solid Waste Services Program

Jan Allen
Cedar Grove Compost Company

Dave Bader
CCR

Ken Bell, Frank Moscone, Jim Austin
Recomp Inc.

Bob Berger
Department of Transportation

Ray Collins
Ben-Franklin Health

Regina Delahunt
Whatcom County Health Dept.

Richard Ellis
Department of Health

Jeff Gage, President
Washington Organic Recycling Council

Sue Hennig
Seattle Metro

Dave Hickok
Seattle-King County Health Dept.

Steve Holderby
Environmental Health Division
Spokane County Health District

Jack Howell
Northwest Cascade

Dr. John Kobayashi
Department of Health
Communicable Disease Epidemiology
Section

Shiou Kuo
WSU - Puyallup Station

Miles McEvoy, Robin Schoer-Nessa
Department of Agriculture

Ron Norton, Frank DiBiase
Tacoma/Pierce County Health Dept.

Gary Pascoe
Environmental Toxicology
International Inc.

Vera Perkins
Seattle Metro Environmental Labs

Dr. Russ Rossenthal, Ph.D.
Department of Transportation

Bob Sargent
Department of Trade
and Economic Dev.
Clean Washington Center

Gabriella Uhlar-Heffner
Seattle Solid Waste Utility

INTERNAL REVIEW COMMITTEE MEMBERS

Steve Diddy
Solid Waste Services

Jim Pendowski, Kyle Dorsey,
Dave Nightingale
Solid Waste Services

Melissa Gildersleeve
CRO

Water Quality Program

Clay Keown
SWRO

Pete Kmet

Tom Laurie

Intergovernmental Liaison

Stewart Lombard
Manchester Lab

Craig McCormack
Toxic Cleanup Program

David Rountry
Hazardous Waste Toxic Reduction
Program

Jim Sachet
SWRO

Joy St. Germain
Solid Waste Services

Eric Schlorff
Water Quality Program

Marnie Tyler
Solid Waste Services

Mike Wilson
Solid Waste Services

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1.0 INTRODUCTION

The "Interim Guidelines for Compost Quality" (Guidelines) were developed to recommend consistent statewide standards for compost quality and to provide guidance to county jurisdictional health departments or districts (JHDs), and producers of compost (processors). These Guidelines are written in response to requests for statewide standards for compost quality from JHDs, local governments and compost processors.

The Guidelines are not a rule, but rather they serve as recommended standards for compost quality. Testing requirements and allowable contamination levels for physical, chemical and biological parameters are provided as suggestions to JHDs. The local JHD issues the permit under which a compost facility operates. Ecology reviews permit applications as submitted by the JHD. Individual JHDs may require more or less stringent standards, as appropriate, given the unique circumstances under which compost will be manufactured and used in their jurisdictions.

Exposure data is not currently available to provide information on the potential ecological and human health risks associated with compost in the environment. The limited primary knowledge, data, and research results for compost has made the development of this guidance document especially challenging.

In the absence of primary research, Ecology reviewed field studies of land application of compost, laboratory data evaluating compost constituents, exposure assessment studies evaluating the impacts of biosolids in the environment, the regulations of other states, provinces and countries, and consulted with experts around the country in drafting the Guidelines.

The Guidelines are being issued as interim because information is incomplete at this time. Ecology recommends that the Guidelines be revised in approximately two years, when new information and more comprehensive data will be available. In order to adequately revise the Guidelines, we recommend that research be promoted in the following areas: potential health risks related to the use of compost, the existence of organic compounds in compost products, potential threats to water quality due to nitrogen release from compost products, the development of standardized analytical laboratory methods for handling compost, and appropriate measures for pathogens that may occur in compost.

The Guidelines were developed by Ecology with the assistance of an external advisory committee comprised of representatives from JHDs, compost processors, citizens, universities, trade organizations, local governments and State Departments of Agriculture, Health, Trade and Economic Development, and Transportation. An internal Ecology committee also reviewed the document, and the Guidelines underwent a six week public review and comment period following public meetings held throughout the state.

Background

The Solid Waste Management--Reduction and Recycling Act, chapter 70.95 RCW, regulates the handling of solid waste in Washington State. Through chapter 70.95 RCW, Washington has placed waste reduction and recycling as top priorities and places composting source separated feedstocks as the preferred recycling management option for organic wastes. According to the Department of Ecology's 1992 Washington State Waste Characterization Study, 24.3 percent of the waste stream by weight is organic (food, yard waste, and other organics) and can be composted. Other wastes, such as wood wastes and paper are not included in this percentage and in some cases may be processed or used as a compost feedstock.

Chapter 70.95 RCW assigns primary responsibility for solid waste planning and management to local governments. Every county is required to prepare a comprehensive solid waste management plan, which must be approved by Ecology. The plans must have a waste reduction and recycling element that includes strategies designed to meet the statewide goal of a 50 percent recycling rate by 1995.

In the past, it was easier to throw the organic materials into landfills or burn them. Today, due to outdoor burn bans, higher tipping fees, landfill closures, and comprehensive waste reduction and recycling programs, local governments are aggressively targeting the organic fraction of the waste stream and encouraging the development of compost facilities.

In addition to reducing the amount of waste going to our landfills, compost provides many other environmental benefits: prevents soil compaction and erosion, provides nutrients and minerals essential for healthy plant growth, increases moisture-holding capacity, supports soil biota that helps suppress plant disease, and improves soil texture.

As more organic materials in the state are processed into compost, greater attention is being focused on developing and encouraging markets for compost products.

The Guidelines address only compost; other soil amendments such as topsoil or fertilizer are not covered. Ecology recognizes that guidance is needed for all soil products comprehensively and plans to collaborate with the Department of Agriculture and other relevant state agencies in pursuing this in the future. Ecology does not want to convey that compost poses greater risk to the environment than do other soil amendments.

Using the Guidelines With Biosolids Feedstock

A state rule is currently being drafted that will apply to biosolids and will parallel EPA's 40 CFR Part 503 rule. Consequently, Ecology recommends that these Guidelines not apply to composted materials that contain a significant proportion of biosolids unless the non-biosolids feedstocks contain levels of pollutants which exceed levels in the biosolids and may pose a threat to human health and environment in the final compost product. However, Ecology recommends that composted material that contains insignificant proportions of biosolids be subject to these guidelines. JHDs are not bound to this recommendation. Significant proportions of biosolids in compost might be determined by examining the relative percentage dry weight, percentage nitrogen contribution, or other measures and through the use of professional judgement. The results of an informal survey of biosolids composting operations in Washington indicate that a range of 13 percent to more than 30 percent biosolids feedstock on a dry weight basis is used to make compost. Levels of biosolids feedstock below this range, for instance less than 10 percent, might be considered insignificant proportions.

Department of Agriculture Registration

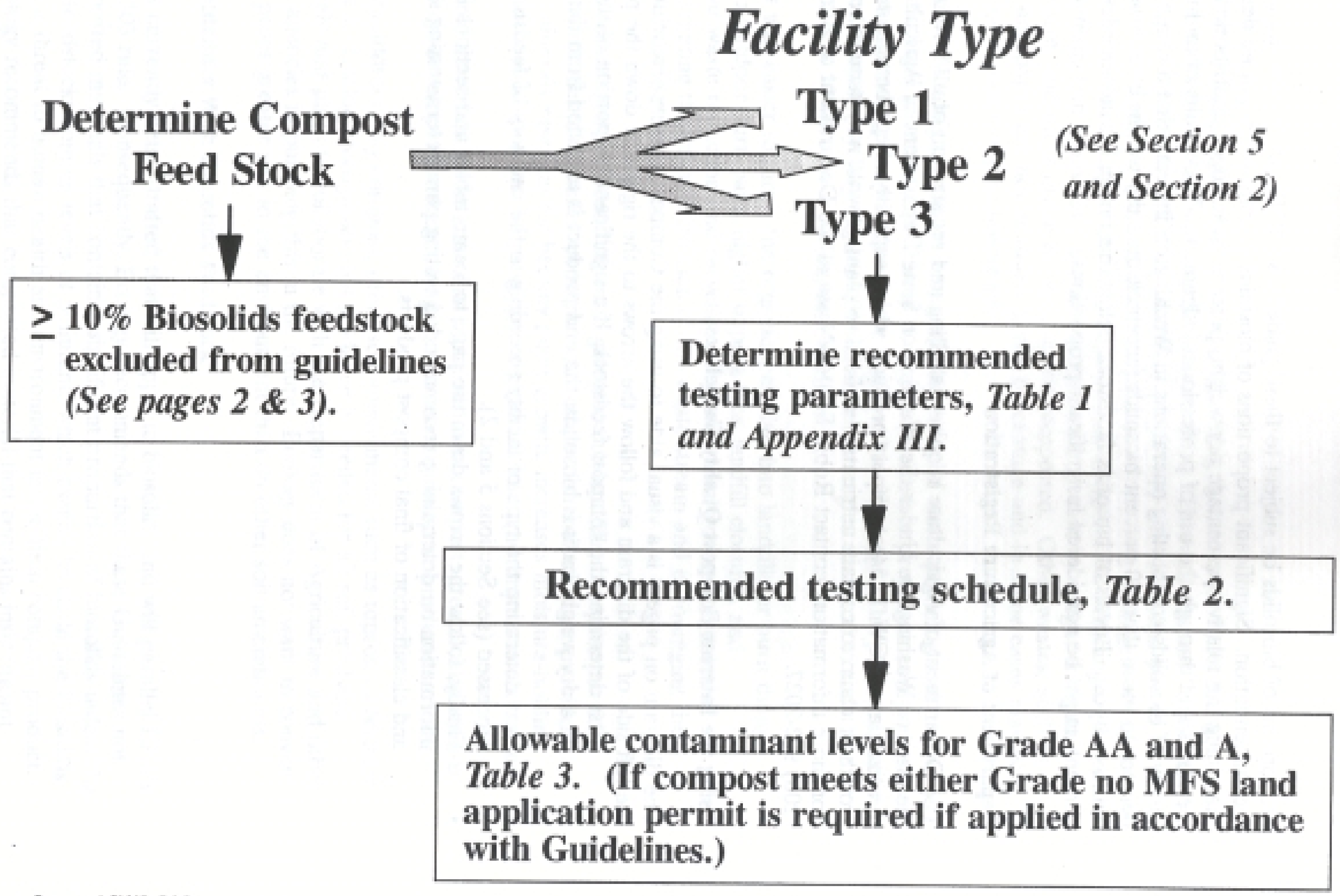
The Department of Agriculture requires labeling and registration of all fertilizers sold in the state of Washington. Under the Washington State Department of Agriculture fertilizer law (RCW 15.54), compost products which explicitly allege benefits to plant growth or claim to contain nutrients beneficial to plant growth, may require registration. For more information, contact Robin Schoen-Nessa at the Department of Agriculture, (206) 902-2027.

Using the Interim Compost Quality Guidelines

The diagram on page 4 is a visual aide to using the Compost Quality Guidelines. Start at the left side of the diagram and follow the arrows to the right and down the page.

- First determine the compost feedstock. If a significant proportion of the feedstock on a dry weight basis is biosolids, the end product is excluded from the Guidelines.
- Next determine the type of facility according to the category of feedstock processed (see Sections 5 and 2).
- Finally, follow the arrows down the page to locate tables and sections for information on determining recommended testing parameters, testing schedules, and classification of final compost products.

USING THE INTERIM COMPOST QUALITY GUIDELINES



Compost.SWS.GAS

2.0 DEFINITION OF TERMS

Agronomic Rate means the rates of application of biosolids, manures, or crop residues in accordance with rates specified by the appropriate fertilizer guide for the crop under cultivation. WAC 173-304-100 (3).

Bio-medical waste, as defined by RCW 70.95K.010, includes animal remains from medical research on animals, biosafety level four disease waste, cultures and stocks, human blood and blood products, pathological wastes, and sharps waste.

Biosolids means municipal sewage sludge, primarily organic semi-solid resulting from the waste water treatment process, that can be beneficially recycled and meets all requirements under chapter 70.95J RCW. Biosolids include septic tank sludge that can be beneficially recycled and can meet all requirements under chapter 70.95J RCW.

Co-Composting means the composting of any combination of two or more wastes or materials.

Compost means the product of composting; it has undergone an initial, rapid stage of decomposition and is in the process of humification (curing)[1].

Composting means the controlled biological degradation of organic solid waste yielding a product for use as a soil conditioner. WAC 173-304-100. For the purposes of these Guidelines, composting does not include the treatment of sewage sludge or biosolids in digesters at waste water treatment plants.

Dangerous waste means those solid wastes designated in WAC 173-303-070 through 173-303-103, in Washington's Dangerous Waste Rule, and includes hazardous wastes regulated under EPA's 40 CFR Part 261 rule.

Ecologically sensitive areas is defined in WAC 197-11-748 (SEPA) and means an area designated and mapped by a county/city.

Facility means all contiguous land (including buffer zones) and structures, other appurtenances, and improvements on the land used for solid waste handling.

Fecal coliform means a bacterium that fits the description of an aerobic or facultative anaerobic gram-negative, non-sporogenous rod bacteria, which ferments lactose, with the production of acid and gas within 24 hours at 44.5 +/-0.2C.

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[1] The definition in chapter 43.19A RCW, Recycled Product Procurement, is as follows, “Compost products means mulch, soil amendments, ground cover, or other landscaping material derived from the biological or mechanical conversion of cellulose-containing waste materials.”

Industrial solid wastes means waste by-products from manufacturing operations such as scraps, trimmings, packing, and other discarded materials not otherwise designated as dangerous waste under chapter 173-303 WAC. (From WAC 173-304-100)

Jurisdictional health department means county or district public health department.

Land Clearing Debris includes leaves, grass, brush, stumps, and raw woody material.

Manufactured Inerts means wastes such as plastic, metals, ceramics and other manufactured items that remain unchanged during composting.

Medical Wastes means all the infectious, and injurious waste originating from a medical, veterinary, or intermediate care facility, chapter 173-304 WAC.

Moderate Risk Waste includes both household hazardous waste and dangerous waste that is exempt from the Dangerous Waste rule because it is from a conditionally exempt small quantity generator or of household origin.

Municipal Solid Waste (MSW) means mixed, unseparated municipal solid waste from residential, commercial, institutional, and industrial sources.

Non-biodegradable Inert Materials includes, but is not limited to glass, metal, plastics, and ceramics (does not include rocks).

Paper Waste includes waste paper from commercial and residential sources as well as paper scraps from the manufacture of various paper products.

Pathogen means an organism, chiefly a microorganism, including viruses, bacteria, fungi, and all forms of human or animal parasites and protozoa, which will produce an infection or disease in a susceptible human host.

Plan of operation means the written plan developed by an owner or operator of a facility detailing how a facility is to be operated during its active life and during closure and post-closure, chapter 173-304 WAC.

Post-consumer food waste is cooked and/or processed food waste, including meats and greases, (e.g., plate scrapings from restaurants).

Pre-consumer food wastes is meat-free uncooked and/or unprocessed vegetable and fruit trimmings, (e.g., trimmings from grocery stores, food preparation from bakeries and restaurants).

Processor means any entity which owns and/or operates a permitted or exempt composting facility.

Recycling means transforming or remanufacturing waste materials into usable or marketable materials for use other than landfill disposal or incineration, chapter 70.95 RCW.

Salmonella is an enteric bacterial pathogen. A further description can be found in "Bergey's Manual of Determinative Bacteriology."

Sewage Sludge means a semi-solid substance consisting of settled sewage solids combined with varying amounts of water and dissolved materials generated from a waste water treatment plant.

Sharps means manufactured inert materials which have a thin, keen edge or a fine point and capable of cutting or piercing, not including wood slivers.

Solid wastes means all putrescible and nonputrescible solid and semisolid wastes, including but not limited to garbage, rubbish, ashes, industrial wastes, swill, sewage sludge, demolition and construction wastes, abandoned vehicles or parts thereof, discarded commodities, and recyclable materials. Chapter 173-351 WAC. This includes all liquid, solid, and semisolid materials which are not the primary products of public, private, industrial, commercial, mining and agricultural operations. Solid waste includes but is not limited to sludge from wastewater treatment plants and septage, from septic tanks, wood waste, dangerous waste and problem wastes. chapter 173-304 WAC.

Source separation means the separation of different kinds of solid waste at the place where the waste originates. chapter 70.95 RCW.

Source-separated specialty wastes means organic wastes which are source-separated, consistent, and homogenous in terms of physical and chemical properties, and which JHDs consider to be relatively low in hazardous substances and human pathogens, for example food waste resulting from food processing. Waste from pulp and paper processing would not qualify for this category.

Stability refers to the point in the composting process when the loss of organic matter and the resulting increase of the proportion of inorganic matter has slowed to the point where subsequent testing provides consistent results. This typically occurs in a range of 30 to 60 percent organic material on a dry weight basis.

Total Coliform is an aerobic or facultative anaerobic Gram-negative, non-sporogenous rod, which ferments lactose, with the production of acid and gas within 48 hours at 35 +/- 0.5 degrees C.

Vactor Waste Solids means wastes consisting primarily of sand collected from catch basins or storm drain systems.

Wood Waste means solid waste consisting of wood pieces or particles generated as a by-product or waste from the manufacturing of wood products, handling and storage of raw materials and trees and stumps. This includes but is not limited to untreated manufacturing wood, used wooden pallets and grates, post-consumer wood wastes, sawdust, chips, shavings, bark, hog fuel, and log sort yard waste, but does not include wood pieces or particles containing chemical preservatives such as creosote, pentachlorophenol, or copper-chrome-arsenate. For the purposes of these Guidelines no treated, coated, or painted wood of any kind should be considered wood waste.

Yard debris means vegetative matter resulting from landscaping maintenance or land clearing operations and includes materials such as tree and shrub trimmings, grass clippings, weeds, trees and tree stumps.

3.0 OBJECTIVES

Composting occurs within the larger field of solid waste management at the local as well as state levels. The Solid Waste Management Reduction and Recycling Act, chapter 70.95 RCW, established the following priorities for solid waste management:

1) Waste reduction;

2) Recycling with source separation of recyclable materials as the preferred method.

3) Energy recovery, incineration, or landfilling of separated wastes; and

4) Energy recovery, incineration, or landfilling of mixed wastes.

The act also set a state goal to achieve a 50 percent recycling rate by 1995. It establishes the responsibilities of county and city governments to assume primary responsibility for solid waste management and to develop and implement aggressive and effective waste reduction and recycling strategies.

Each county in the state, in cooperation with the various cities located within such county, is required to prepare a coordinated, comprehensive solid waste management plan to achieve this 50 percent recycling goal. Composting can be used to reach this goal.

The objectives of the "Interim Guidelines for Compost Quality" are:

To protect the environment and public health of Washington state and its citizens;

To promote Washington's waste reduction, recycling and recycled content procurement goals by providing guidance to government procurement contractors on compost quality;

To recommend consistent statewide quality standards, sampling protocol and testing procedures for compost products;

To provide guidance and information to jurisdictional health departments, consumers, and processors on compost quality;

To promote compost product procurement from those facilities that have, or are exempt from, solid waste handling permits issued by the JHD.

To ensure consumer confidence through consistent statewide product quality standards;

To ensure that composting is allowed to develop as an environmentally sound waste management practice implemented by local industry and governments.

4.0 SCOPE

JHDs issue solid waste permits under the MFS rule, in accordance with an approved comprehensive solid waste management plan. JHDs are primarily responsible for enforcement and inspection at those facilities, many of which include composting operations.

The Guidelines are primarily focused on those facilities required to have a solid waste handling permit as required by the Minimum Functional Standards for Solid Waste Handling (MFS), chapter WAC 173-304[2]. JHDs can require more or less stringent standards as appropriate to the specific site, facility, and operating characteristics of a composting operation. Consult with the JHD or Regional Ecology office for questions about facility permitting. Composting facilities not required to have a permit under chapter 173-304 WAC are also encouraged to test their products in accordance with these Guidelines.

Regardless of the permit status of a facility that performs composting, these guidelines establish interim compost quality allowable contaminant levels and application rates which are believed to be protective of human health and the environment. Therefore, Ecology recommends that compost meeting the two grades of quality and applied as recommended in these guidelines, not require a solid waste land application permit.

[2] For an overview of the laws that apply to solid waste and compost see Appendix I.

5.0 FACILITY TYPES BY FEEDSTOCKS

The Guidelines focus, in general, on the final product quality rather than the feedstocks when evaluating appropriate compost usages. However, for the purposes of testing it is useful to look at the feedstock materials to determine the most appropriate testing regime.

Three facility types representing the most commonly composted feedstocks and/or combination of feedstocks are listed below. They are named Type 1, 2, and 3, and represent increasingly complex (heterogeneous) feedstocks. The objective of delineating facility types is to differentiate the testing parameters and testing frequency for each facility.

Upon reviewing a processor's plan of operation, including the list of feedstocks to be accepted and the amount of feedstock, the JHD should determine the appropriate facility type and testing frequency for each facility.

The JHD may require processors wishing to compost feedstocks not listed or identified in the following three facility types to submit specific feedstock testing for evaluation.

Compost feedstocks should not include any moderate risk wastes nor any regulated hazardous or dangerous wastes as defined under chapter 173-303 WAC. Soils contaminated with petroleum should not be included as a feedstock in the composting process and should not be blended with finished compost products. The three facility types, based on their feedstocks, are as follows:

> **Type 1**: Wood wastes[3]; source separated yard and garden wastes; agricultural crop residues; manures from herbivorous animals; pre-consumer meat-free food wastes or other source separated specialty wastes or any combination thereof that the JHD considers to be relatively low in hazardous substances, human pathogens and physical contaminants.
>
> **Type 2:** Biosolids; meat and post-consumer source separated food wastes or other similar source separated specialty wastes or any combination thereof (or in combination with wastes from type 1) that the JHD considers to be relatively low in hazardous substances and physical contaminants, but are likely to have high levels of human pathogens.
>
> **Type 3:** Mixed municipal solid wastes; post collection separated or processed solid wastes; industrial solid wastes; industrial biological treatment sludges or other similar compostable organic wastes or any combination thereof (or any combination with types 1 or 2) that the JHD considers to have relatively high levels of hazardous substances, human pathogens and/or physical contaminants.

[3] Wood waste does not include any coated, painted, or treated wood, as defined in Chapter 2 of the Guidelines.

6.0 TESTING PARAMETERS

The compost quality testing parameters listed here are recommended for use by the JHD. The JHD may deem it appropriate to require additional or fewer test parameters based on feedstocks and anticipated application of the compost product. The testing parameters listed here do not consider marketing parameters, but rather consider those parameters which may be a potential threat to the environment or public health.

The testing parameters were chosen after careful review of existing compost product data, Ecology regulations, EPA's 40 CFR Part 503 rule (Standards for the Use and Disposal of Sewage Sludge), compost regulations from other states and countries, and reports written by consultants contracted to draft quality standards.

Testing parameters are listed by facility type. Additional testing beyond that listed here is recommended for feedstocks that are more complex and/or heterogenous. The tests recommended for each facility type are shown on Table 1.

Testing for Small, Type 1 Facilities

After achieving consistent baseline operating test results on a facility's product, Ecology recommends less testing for Type 1 facilities (facilities handling cleaner, source-separated materials) processing less than 10,000 dry metric tonnes per year (MTPY, where a metric tonne is 2204.6 pounds) of feedstock. Ecology makes this recommendation in the interest of promoting composting by reducing economic burdens for smaller composting businesses. Ecology believes it is still important to test products more at first to establish baseline operating results when a business is new, or has significantly altered its feedstock or process to the point where compost quality cannot accurately be predicted.

Unless other contaminants are determined by the JHD to be problematic, Ecology recommends that the minimum testing for these facilities include pH, cadmium, lead, chlordane, pentachlorophenol, ammonia, nitrate, total Kjeldahl nitrogen and, if appropriate, total petroleum hydrocarbons. Cadmium serves as an indicator of the possible presence of feedstocks that are not in the Type 1 category. Lead has been found to be problematic in some Type 1 feedstocks and is an ubiquitous contaminant that can pose a significant risk to public health. Chlordane and pentachlorophenol are included because they are sometimes found as contaminants in yard waste compost. Additional information on these compounds is provided in Appendix III. Ammonia, nitrate and total Kjeldahl nitrogen information is necessary in order to calculate agronomic rates which will help prevent nutrient overloading.

Pathogen Indicators

Ecology supports the composting alternatives that demonstrate Class A pathogen reduction, per 40 CFR Part 503.32 (Standards for the Use and Disposal of Sewage Sludge). These alternatives, called Processes to Further Reduce Pathogens (PFRP), require that compost materials reach 55 degrees Celsius for a specific length of time, depending on the process. The objective of these requirements is to reduce pathogen densities to below detectable limits.

Ecology recommends using a modified fecal coliform test as an indicator of how completely a composting process has destroyed human pathogens. Appendix IX contains recommended sample preparations and adaptations of the multiple tube fermentation technique in Standard Methods for Water and Wastewater, 18th Edition (SM18 9221 B and E). Membrane filter techniques should not be used for compost samples because the solids loading on the filter would not permit a reliable count of fecal coliform colonies.

Ecology recommends that operators of Type 1 facilities test for pathogen indicators at the point in the process just after PFRP is complete. Timing for pathogen indicator testing of compost containing any amount of biosolids must be in accordance with 40 CFR Part 503.

During the interim phase of the Guidelines, Ecology will promote the use of the method described in Appendix IX in an effort to gather data on pathogen reduction at composting facilities across the state. Future revisions may include different pathogen indicator limits for different facility types.

TABLE 1

TESTING PARAMETERS BY FACILITY TYPE

Testing Parameter	Type 1		Type 2	Type 3
PHYSICAL	≤10000 MTPY[4]	>10000 MTPY		
Percent of Manufactured Inerts	X	X	X	X
Sharps	X	X	X	X
Stability	X	X	X	X
CHEMICAL				
pH	X	X	X	X
Ammonia	X	X	X	X
Arsenic		X	X	X
Cadmium	X	X	X	X
Chromium		X	X	X
Copper		X	X	X
Lead	X	X	X	X
Mercury		X	X	X
Molybdenum			X	X
Nickel		X	X	X
Nitrate	X	X	X	X
Organic nitrogen	X	X	X	X
Selenium			X	X
Zinc		X	X	X
PCBs			X	X
Total Petroleum Hydrocarbons[5]	X		X	X
Other Organic Compounds[6]	X		X	X
BIOLOGICAL:				
Fecal Coliform	X		X	X

4 Reduced testing recommendations for established facilities, MTPY = dry metric tonnes per year.

5 Ecology encourages the JHD to require testing for Total Petroleum Hydrocarbons whenever soil that is likely to be contaminated with petroleum hydrocarbons is incorporated as a feedstock or is mixed with a finished compost product, as explained in Appendix III.

6 As explained in Appendix III.

7.0 TESTING FREQUENCY

The testing frequency matrix is offered as guidance to the JHD as a suggested testing program for **established** facilities. JHDs may confer with the regional Ecology Solid Waste Program when facilities are operating under unique circumstances.

Ecology recommends that more extensive testing be conducted when a facility is just starting up, has no previous testing history, or has significantly altered its feedstocks or processes to the point that product quality cannot be accurately predicted. In determining the extent and frequency of testing during this initial phase, JHDs may find it helpful to review quality data of compost derived from a similar feedstock to gain knowledge about the categories of contaminants that are likely to be present. In Washington, data will be available from Ecology's Environmental Investigations and Laboratory Services (EILS) program; data sets across the country supply useful information as well. Appendix VIII contains a compilation of data on chemical constituents in compost made from a variety of feedstocks around the world. In addition, the JHD may also consult with Ecology when establishing a testing schedule during this initial phase.

The initial testing period may vary widely, from a few months to a few years, depending on the variability that is present in the feedstocks and testing results. We recommend that an adequate baseline of information be collected through testing events that are distributed over time to account for seasonal fluctuations that may occur in the feedstock material. The purpose of the initial period is to observe the extent of the variability that may be present in the final product and to establish a statistically significant baseline of compost product quality at a facility under certain conditions. Once the compost's quality can be predicted, i.e. there is consistency in the test results within a range, the JHD may wish to reduce testing for those parameters where a problem does not seem to occur. If data indicates that high variability in the final product is inherent in the feedstock, extensive testing may be a standard component of the testing plan. Because of the complexity of the Type 3 feedstocks, Ecology recommends more extensive testing of Type 3 facilities in order to establish an adequate baseline of information.

When a facility is established, that is, has achieved predictable testing results, Table 2 is recommended as a testing schedule, based on the type of facility and the number of dry metric tonnes per year (MTPY) of feedstock that are processed. The estimated costs are on an annual basis for minimum recommended testing. Actual lab costs may be less, but with supplemental testing or when establishing baseline data would be more expensive than shown in Table 2. Prices estimated include lab split samples and lab duplicates.

TABLE 2

RECOMMENDED TESTING SCHEDULE AND ESTIMATED COSTS

Facility Type	Test Category	< 10,000 MTPY	≥ 10,000 MTPY	Estimated Cost/Yr
Type 1	Metals and Pathogen Indicators	once per year	every 10,000 dry MT or every six months whichever comes first	$585 to $1950
	Organics	once per year	once per 6 months	
Type 2	Metals and Pathogen Indicators	once per quarter	every 5,000 dry MT or every other month whichever comes first	$1725 to $3050
	Organics	once per year	once per 100 days	
Type 3	Metals and Pathogen Indicators	every 1,500 dry MT	every 1,500 dry MT or once per month whichever comes first	$12,270 or less
	Organics	every 1,500 dry MT	once per 60 days	

The JHD has the discretion to reduce or increase the number of parameters tested for and/or the frequency of testing, if they feel the reduction or increase is warranted and is still protective of the environment and public health. Depending on the results of the baseline data that establishes the compost quality at a facility under certain conditions, it may be advisable to test periodically for additional physical, chemical or biological parameters.

8.0 TESTING AND MONITORING

A homogenous waste stream and carefully controlled process help to ensure production of a final product which is consistent and predictable. Testing and monitoring are necessary to verify that compost products meet the recommended standards. Two essential ingredients for testing accuracy are a stable compost and a well-thought-out Quality Assurance (QA) plan. The JHD determines how elaborate the QA plan must be. The "Testing Procedures and Quality Assurance Project Plan", Appendix VI of these Guidelines, outlines the steps involved in producing a quality assurance plan.

A stable compost is essential for consistent test results. As feedstocks decompose and the weight of organic matter decreases, the relative concentration of non-volatile inorganic contaminants (such as heavy metals) increases. If testing occurs before the compost has reached stability then testing results may be inaccurate.

The point in time (e.g. the nth day of composting) when the product is stable enough for accurate test results will vary for each facility. We suggest the processors and the JHD work together to determine the point of stability in their compost process by employing one or more of the methods described in Appendix IV or other mutually agreeable method(s).

When process and feedstocks are relatively consistent, and the point of stability has been identified, it should remain fairly constant and further testing may not be necessary. It may be advisable to perform periodic spot tests to verify ongoing stability. If, however, feedstocks or process are significantly altered, then the point of stability should be re-established.

The QA project plan should be complete before any sampling or testing takes place. The plan should be prepared by the facility staff responsible for monitoring the product. The draft plan should be reviewed and the final plan approved by the JHD. The QA Section of the Environmental Investigations and Laboratory Services (EILS) Program of the Department of Ecology is available to assist with project plan review upon request.

The QA project plan serves two important functions. First, the preparation of the plan helps the facility staff anticipate the requirements of their monitoring program. Second, the completed plan facilitates communication among management, the facility staff who collect and ship the samples, and the analytical laboratory. The plan can also be useful for training new staff who will be working on compost monitoring.

Sampling should be conducted by facility staff following a written QA project plan. Analyses must be performed by an analytical laboratory should use the methods specified in the "Testing Procedure and Quality Assurance Project Plan." See Appendix VI. The QA project plan should always be provided to the analytical laboratory when requesting analytical services. Test results should be sent to the JHD for review.

The Ecology EILS program has agreed to establish a statewide data base of Washington compost facility test results to be used in updating these guidelines. Participation is requested in this voluntary program, and the data collected can be protected under Ecology's confidentiality statute, RCW 43.21A.160. Requests for confidentiality should be made in writing to Ecology. Test results should be sent to:

Stewart Lombard
EILS Program
Quality Assurance Section
Department of Ecology
PO Box 488
Manchester, WA 98353-0488

9.0 NUTRIENTS AND WATER QUALITY

Nutrient leaching from nutrient-rich compost poses a potential threat to surface and ground water quality. The Guidelines strive to further the beneficial use of compost without compromising water quality standards outlined in the Water Quality Standards for Ground Waters of the State of Washington, chapter 173-200 WAC. Chapter 173-200 is consistent with Washington's antidegradation policy which is generally guided by chapter 90.48 RCW, the Water Pollution Control Act, and chapter 90.54 RCW, the Water Resources Act of 1971.

In order to protect groundwater, all soil amendments such as compost should be spread at agronomic rates at the appropriate time of the year. For the purposes of this discussion, "agronomic rate" refers to the application of compost in accordance with plant nutrient needs, including nitrogen, phosphorus, and potassium. The timing of application is as important as the amount of nutrient present in the compost. The appropriate timing of application is a function of the soil properties, climate and crop management conditions.

To obtain assistance in calculating agronomic rates at a specific site, contact the local Soil Conservation Service, Washington State University Extension Service or other qualified agronomist.

There are also some studies that have demonstrated a beneficial use of certain composts to absorb excess nitrogen and thereby improving surface water or storm water quality.

10.0 COMPOST CLASSIFICATIONS AND APPLICATION RATES

Compost is beneficial as a soil amendment for many purposes: food crops, horticulture, silviculture, topsoil blends, turf, and other applications. The Guidelines identify Grade AA and Grade A compost that are available to the general public. Both are equally protective of the environment and public health when used in accordance with the Guidelines.

Ecology recommends that Grade AA or a Grade A compost be applied at a rate of up to 200 dry metric tonnes per hectare annually for most purposes. This application rate takes into account cumulative metal loading over a period of several years and also serves to protect ground water quality from potential overloading of nutrients.[7] In some cases, an application of greater than 200 MT/ha/yr is desirable. Refer to Appendix II for guidance on when this is appropriate and for information on how to calculate application rates in these unique circumstances.

Grade AA Compost

Compost products meeting the testing criteria for Grade AA class are encouraged to include an information sheet with the product at the time of sale. Processors selling materials in bulk may prefer to have this information sheet posted at the site of sale. We suggest that this information include the following:

1. The identifying label "Grade AA Compost, as described in Washington State Department of Ecology's Interim Guidelines for Compost Quality."

2. The statement "We recommend that Grade AA Compost be applied at a rate of up to 200 dry metric tonnes per hectare per year." Any equivalent application rate language may be substituted, as is appropriate for the anticipated end use; equations for converting this application rate into other units (wet weight, inches, cubic yards, lbs/ft^3, etc.) are supplied in Appendix II. The units used should reflect the audience of the intended market. Application rates will vary with the bulk density and percent moisture of each unique compost product. Ecology recommends three inches per year as a default.

3. A list of all feedstocks present in percentages or weight per dry pound, in order of decreasing dry weight.

4. The statement "Recommended for home gardens and other areas where there is a likelihood of repeated application or high contact by children which could result in direct ingestion through normal hand-to-mouth activities".

Processors may wish to include additional information, such as a brief explanation of what compost is and the benefits derived from its usage, as appropriate.

[7] A detailed explanation of how metal levels were derived is contained in Appendix II, also see Appendix III.

Ecology recommends that Grade AA Compost be made by Type 1 and Type 2 facilities only.[8]

Grade A Compost

Processors are encouraged to include an information sheet with compost products meeting the testing criteria for Grade A class of compost at the time of sale. Processors selling materials in bulk may prefer to have this information sheet posted at the site of sale. We suggest that this information include the following:

1. The identifying label "Grade A Compost, as described in Washington State Department of Ecology's Interim Guidelines for Compost Quality."

2. The statement "We recommend that Grade A Compost be applied at a rate of up to 200 metric tonnes per hectare per year." Any equivalent application rate language may be substituted, as is appropriate for the anticipated end use; equations for converting this application rate into other units (inches, cubic yards, lbs/ft^3, etc.) are supplied in Appendix II. The units used should reflect the audience of the intended market. Application rates will vary with the bulk density and percent moisture of each unique compost product. Ecology recommends three inches per year as a default.

3. A list of all feedstocks present in percentages or weight per dry pound, in order of decreasing dry weight.

4. The statement "Recommended for topsoil blends, landscaping, ornamental, silvicultural purposes, sod farms, and similar applications."

Processors may wish to include additional information, such as a brief explanation of what compost is and the benefits derived from its usage, as they see appropriate.

Allowable Contaminant Levels For Grade AA And Grade A Compost

Table 3 lists allowable contaminant levels in compost for Grades AA and A. All values listed in Table 3 are in parts per million (ppm) or percentage on a dry weight basis except for pH.

Ammonia, nitrate, and organic nitrogen tests should also be performed to calculate agronomic application rates.

[8] Additional research and data on Type 3 Facilities will be reviewed when the Guidelines are revisited.

TABLE 3

ALLOWABLE CONTAMINANT LEVELS FOR COMPOST

PARAMETER		Grade AA Compost	Grade A Compost
PHYSICAL			
Percent of Manufactured Inerts		< 1 %	< 1 %
Sharps		None	None
Stability		See Appendix IV	See Appendix IV
CHEMICAL: INORGANIC			
pH		5.5 - 8.0	5.5 - 8.0
Arsenic		20 ppm	20[9] ppm
Cadmium		10[10] ppm	39 ppm
Chromium		600 ppm	1200 ppm
Copper		750 ppm	1500 ppm
Lead		150 ppm	300 ppm
Mercury		8 ppm	17 ppm
Molybdenum[11]		9 ppm	18 ppm
Nickel		210 ppm	420 ppm
Selenium[11]		18 ppm	36 ppm
Zinc		1400 ppm	2800 ppm
CHEMICAL: ORGANIC		Also See Appendix III	Also See Appendix III
PCB's[12]		1 ppm	1 ppm
Total Petroleum Hydrocarbons (TPH)[13]	gasoline	100 ppm	100 ppm
	diesel	200 ppm	200 ppm
	other	200 ppm	200 ppm
BIOLOGICAL:			
Fecal coliform		Meet or exceed Class A requirements for biosolids*	Meet or exceed Class A requirements for biosolids*

9 Based on background soil concentrations in Washington state; direct contact numbers determined by Method B of Washington's Model Toxic Control Act (MTCA) are below background soil concentrations.

10 Based on cumulative loading limits specified for foodchain crops in 40 CFR 257.3-5.

11 Type 1 Facilities are not required to test for this parameter.

12 Based on direct contact limits (MTCA Method B); Type 1 facilities are not required to test for PCBs.

13 For soil and vactor waste feedstock; cleanup level based on protection of ground water (MTCA Method A).

The total petroleum hydrocarbon (TPH) testing of compost can result in false positive lab value due to natural oils from wood and yard debris. Consequently, TPH testing should be performed on feedstock such as soil and vactor waste solids that may contain petroleum hydrocarbons. A TPH screening test can be used to identify the presence of petroleum products in non-organic feedstocks. See Table 5.

Composted Materials Exceeding Allowable Contaminant Levels For Grade A Compost

Composted materials that fail any contaminant levels for Grade A compost may still have a beneficial use. However, these materials should be used under restricted conditions and would be subject to all solid waste laws. Application of these materials would require a solid waste handling permit issued by the JHD. Such compost should not be diluted with other materials in order to meet the allowable contaminant levels or bypass the recommended standards (unless the material will undergo additional composting following the addition of other materials). JHDs may contact Ecology's regional offices for additional guidance.

APPENDIX I SUMMARY OF COMPOST FACILITY SOLID WASTE REQUIREMENTS (PERMITS) BASED ON FEEDSTOCKS

The following list of permits and requirements is provided as a quick reference. Additional permits or no permits may be required in a specific locale. Ecology encourages processors to confer with the JHD for a complete list of all applicable health and environmental permits and operating requirements.

TABLE 4

SOLID WASTE PERMITTING REQUIREMENTS APPLICABLE TO COMPOST PILES.

Waste Type	Pile Recycling Rules in 173-304-300 WAC	Facility Storage Pile Rules in 173-304-420 WAC	Permit Application Req.
Garbage • Food wastes, • Sewage sludge, • Food waste mixed with sewage sludge or yard waste, • municipal waste	no	yes	173-304-600(3)(e) WAC
Other Solid Waste • yard wastes, landclearing debris, wood waste, • animal manure, • paper waste	yes [14]	no	173-304-600(3)(h) WAC

comp

[14] Unless the jurisdictional health department finds that piles are not being used for recycling purposes, in which case the pile standards of –420 must be met. See –300(3)(c)(i and ii) and –600(3)(e).

APPENDIX II: DERIVATION OF CONTAMINANT LEVELS

Currently, environmental risk-based exposure assessments of contaminants in compost are not available. In the absence of this information, Ecology has reviewed exposure assessments for biosolids, existing literature, other states and countries regulations, and toxicity data on metals and organic compounds.

Ecology believes that EPA's recently published 40 CFR Part 503 provides the most comprehensive exposure assessment information for land-applied materials. Therefore, Ecology used EPA's exposure assessment information in developing numerical limits for compost.

40 CFR Part 503 is the product of many years of practical field experience and laboratory research on the qualities and behavior of biosolids. While the information is very valuable, the unconditional direct use of the standards contained in Part 503 as a basis for compost quality is not appropriate. Because of the chemical and structural differences between biosolids and compost, the fate of chemical compounds and metals in compost after being placed in the soil environment cannot be accurately predicted. This does not mean that Part 503 should not be adapted for regulating compost quality, but that the rule and standards were not specifically developed or intended for this purpose. EPA will not endorse the direct application of the Part 503 contaminant limits for materials other than biosolids, but supports Ecology's opinion that Part 503 is a good starting point for developing compost guidance in Washington state.

A. Applying the Logic of 40 CFR Part 503 to Contaminant Levels for Compost in Washington State

In developing contaminant levels for compost, Ecology used two tables from Part 503, Table 2-Cumulative Pollutant Loading Rates (40 CFR 503.13 (b)(2)), and Table 3-Pollutant Concentrations (40 CFR 503.13 (b)(3)).

Part 503 table 2 values were based on EPA's risk assessment and reflect the maximum metal loading that should ever be applied to a site. The Part 503 table 3 values were derived from the cumulative loading rates specified in table 2 (with two exceptions, as explained in Part 503). In calculating the table 3 numbers, EPA made several assumptions about the physical properties of biosolids and what constitutes "typical" application rates for biosolids. This assumption is an important distinction between biosolids and compost and exemplifies an area where Part 503 must be adjusted to work for a compost product. Compost is generally applied at a rate many times thicker than the "typical" biosolids application. Therefore, at the same contaminant limits, sites where compost is applied at many times the biosolids thickness, the site may be limited to fewer applications (e.g. have a shorter site life).

Part 503 makes the following assumptions about biosolids application:

- * The bulk density of biosolids is 1.0 gram per cubic centimeter (g/cm^3) measured on a dry weight basis;
- * 10 metric tonnes, dry weight, will be applied per hectare per year (equivalent to about 0.04 inches deep using the 1.0 g/cm^3 density); and
- * The life of a site will be 100 years.

Ecology assumes that the cumulative loading values stated in 40 CFR 503.13 (b)(2), Table 2 - Cumulative Pollutant Loading Rates, are an acceptable starting point for deriving contaminant limits for compost, but suggests that the following assumptions are more appropriate for compost than are the assumptions made by EPA about biosolids in Part 503:

- * Compost has an average dry weight bulk density of 0.25 g/cm^3.
- * Compost will be applied at a rate of 200 metric tonnes (dry weight) per hectare per year (200 MT/ha/yr).

Ecology selected 200 MT/ha/yr based on input from landscape architects and designers, home gardeners, agriculture extension staff, soil scientists, and compost processors that a three-inch application was "typical" for compost. While many applications require less compost than three inches, home gardeners may use more. Three inches reflected a "middle of the road" application.

Ecology calculated the dry weight application rate of 200 MT/ha/yr of this "typical" three inches of compost using an assumed <u>wet</u> bulk density of 0.525 g/cm^3 with a moisture content of 50 percent. In making these assumptions, Ecology reviewed data of compost made from several different types of feedstocks in Washington and across the United States. Ecology recognizes that bulk density and moisture content vary widely, even within a given type of feedstock.

Additional rationale supporting the 200 MT/ha/yr application lies in Ecology's concern that potential nutrient loading and subsequent threats to groundwater quality may occur at applications greater than 200 MT/ha/yr. In addition, if Grade A Compost is applied at a rate of 200 MT/ha/yr, cumulative metal loading levels will be reached in five applications, as demonstrated below. Ecology chose to select as a general recommendation an application rate that would allow no less than five applications. For those unique circumstances where a one- or two-time application is desired, guidance is provided under section D of this appendix.

It is more appropriate to think of the site life in terms of the number of years in which compost may be applied rather than in consecutive application years (applications need not be made in consecutive years). Using this concept the number of years or number of applications of 200 MT/ha (dry weight) can be calculated. This calculated number of applications will determine the point at which the cumulative loading level is reached.

The calculation for the number of applications for site life includes the cumulative pollutant loading value, application rate of compost in dry metric tonnes, and the contaminant level of the chemical of concern in the compost. This equation can be represented for a given chemical as:

Cumulative Loading Limit (site life) X Application Rate (dry MT) X
(from Part 503, Table 2) in kg/ha in ha/kg compost

Compost Contaminant Level = Number of Site Life Apps
in (mg/kg) x 10^6

The compost contaminant level is typically represented in mg/kg. The numerator must be converted from mg to kg to use in this equation so that all weights are in kg. To do this you can multiply the numerator and denominator by 10^6.

$$\frac{\text{mg}}{\text{kg}} \times \frac{10^6}{10^6} = \frac{\text{kg Contaminant}}{\text{kg }(10^6)\text{ Compost}}$$

In order to end up with the correct units in the equation this compost contaminant level must be represented with the values and units in the fraction switched, kg of contaminant on the bottom and kg(10^6) of compost on the top.

Example: Grade A compost limit for Nickel, using a 200 MT/ha/yr application rate.

By using the cumulative loading limit from Table 2 of Part 503, the application rate of 200 MT/ha/yr, and the Grade A compost limit for nickel, it is demonstrated that the total allowable accumulation of nickel will be reached in five applications.

$$\frac{\text{420 kg Ni (site life)}}{\text{ha}} \times \frac{\text{1 ha x application}}{\text{200,000 kg compost}} \times \frac{10^6\text{ kg compost}}{\text{420 kg Ni}} = \text{5 site life applications}$$

200,000 kg is equivalent to 200 MT. If less than 200 MT is applied, the site life will be longer; if more than 200 MT were to be applied, the site life will be shorter.

Because Grade AA Compost has allowable Ni concentration limits that are one-half of the Grade A limits, the cumulative loading limits for Grade AA compost will not be reached for ten applications, as shown below:

$$\frac{\text{420 kg Ni (site life)}}{\text{ha}} \times \frac{\text{1 ha x application}}{\text{200,000 kg compost}} \times \frac{10^6\text{ kg compost}}{\text{210 kg Ni}} = \text{10 site life apps.}$$

B. Rationale Behind the Levels for Grade AA Compost

Ecology made a policy decision to have two classes of compost that would be suited for different types of applications. This was done for three reasons: 1) the absence of comprehensive data regarding the behavior of contaminants in compost applied to land; 2) EPA's unwillingness to endorse Part 503 for materials other than biosolids; and 3) the relatively short site life (five applications) associated with "typical" applications of Grade A compost. For these reasons, Ecology chose to cut the Grade A contaminant levels in half (with the exception of arsenic and cadmium, as explained in footnote 9 to Table 3 and section E of this appendix) and create Grade AA compost. This increases the life of a site to ten applications, much more practical for home gardens, and provides a level of safety for those applications where human contact is likely and the potential exists for children to directly ingest compost through normal hand-to-mouth activities.

C. Converting Densities and the Recommended Application Rate into Other Units

Compost density may be calculated in any number of units. The following bulk density conversions are provided for converting density measurements into g/cm^3 or vice versa.

Bulk Density Conversions	Example of Each
$lb/ft^3 \times 0.016 = g/cm^3$	$20\ lb/ft^3 \times 0.016 = 0.32\ g/cm^3$
$lb/yd^3 \times 0.000593 = g/cm^3$	$1000\ lb/yd^3 \times 0.000593 = 0.59\ g/cm^3$
$kg/m^3 \times 0.001 = g/cm^3$	$250\ kg/m^3 \times 0.001 = 0.25\ g/cm^3$
$g/cm^3 \times 62.43 = lb/ft^3$	$0.30\ g/cm^3 \times 62.43 = 18.7\ lb/ft^3$
$g/cm^3 \times 1685.6 = lb/yd^3$	$0.30\ g/cm^3 \times 1685.6 = 506\ lb/yd^3$

The processor may wish to express the application rate in terms of wet weight per unit area, or in terms of volume. These are relatively simple calculations and require minimal information about the physical parameters of the compost product, e.g. percent solids (or percent moisture), and bulk density. The following conversions are presented to assist processors and JHDs in converting to other units.

1. Wet Weight and Dry Weight Conversions

$$\frac{\text{200 MT/ha/yr dry weight}}{\text{\% Solids/100}} = \text{Wet MT/ha/yr}$$

OR:

$$\frac{\text{200 MT/ha/yr dry weight}}{\text{(100 - \% Moisture)/100)}} = \text{Wet MT/ha/yr}$$

Example: Given 200 MT dry weight and compost with 50% solids by weight

$$\frac{\text{200 MT/ha/yr dry weight}}{\text{50\% Solids/100}} = \text{400 wet MT/ha/yr}$$

Conversely, Wet Weight x (% Solids /100) = Dry Weight

2. Wet MT to Inches

Wet MT/ha x (1/(Wet Bulk Density in g/cm^3)) x 0.00394 =
Number of inches (wet weight)

Example: 400 MT/ha x (1/(0.525 g/cm^3)) x 0.00394 = 3 inches (wet weight)

(where 0.00394 inches = $\frac{MT}{ha}\ \frac{10^3 kg}{MT}\ \frac{10^3 g}{kg}\ \frac{cm^3}{Xg}\ \frac{m^2}{100^2 cm^2}\ \frac{ha}{10{,}000\ m^2}\ \frac{inches}{2.54\ cm}$)

3. Wet MT/ha to Cubic Yards (yd^3)

Wet MT/ha x (1/(Wet Bulk Density in g/cm^3)) x 1.3 = Number of yd^3/ha

Example: 400 MT/ha x (1/(0.525 g/cm^3)) x 1.3 = 990 yd^3/ha

(where 1.3 $\frac{yd^3}{ha} = \frac{MT}{ha}\ \frac{10^6 g}{MT}\ \frac{cm^3}{Xg}\ \frac{m^3}{100^3 cm^3}\ \frac{yd^3}{0.7646\ m^3}$)

4. Wet MT/ha to Pounds per Square Foot (lb/ft^2)

Wet MT/ha x 0.02 = Number of lb/ft^2

Example: 400 MT/ha x 0.02 = 8 lb/ft^2

(where 0.02 lb/ft^2 = $\frac{MT}{ha}\ \frac{10^6 g}{MT}\ \frac{lb}{454g}\ \frac{hg}{10{,}000\ m^2}\ \frac{0.3048^2\ m^2}{ft^2}$)

5. Wet MT/ha to Short Tons per Acre (tons/acre)

Wet MT/ha x 0.44 = Number of tons/acre

Example: 400 MT/ha x 0.44 = 176 tons/acre

(where 0.44 tons/acre = $\frac{MT}{ha}\ \frac{tons}{0.9072\ MT}\ \frac{ha}{2.4711\ acres}$)

D. Applications Greater than the Recommended 200 MT/ha/yr.

In some instances, applications greater than 200 MT/ha/yr dry weight of Grade AA or Grade A compost may be desirable. Ecology does not recommend one-time applications of compost that approach cumulative loading limits for two reasons: 1) the cumulative loading limits established in Part 503 are based on biosolids; we cannot be certain that in the environment metals existing in the compost matrix behave in the same way as do metals in the biosolids matrix, and 2) future land uses cannot be predicted.

Some circumstances are more conducive to one-time applications than others. Areas where it would be undesirable to have a one-time application include areas in proximity to drinking water supplies or where future use may change and the site could be used for food-chain crop production. Circumstances that are better suited for one-time applications include areas zoned as industrial or light industrial, areas of restricted access, such as highway shoulders or medians, or areas designated for specific purposes where future use is not likely to change.

If it has been determined that an application greater than 200 MT/ha/yr is desirable, calculations can be used to ensure that cumulative loading limits are not exceeded. When exceeding the recommended 200 dry MT/ha/yr application rate, Ecology recommends calculation of agronomic rates. Any application of compost is required to be in compliance with chapter 173-200 WAC, Water Quality Standards for Ground Waters of the State of Washington.

1. Determine the Proportion of Cumulative Metal Loading that will be Applied.

The JHD may wish to restrict each application to a certain percentage of the cumulative allowable loading rate. The following allowable cumulative loading limits are based on Table 2 of Part 503 (with the exception of cadmium, which is based on 40 CFR 257 as described in part E of this appendix). All units are based on dry weight measurements:

Contaminant	Cumulative Loading Limit, kg/ha
Arsenic	41
Cadmium	20
Chromium	3000
Copper	1500
Lead	300
Mercury	17
Molybdenum	18
Nickel	420
Selenium	100
Zinc	2800

For example, if the JHD wanted to restrict each application to 25 percent of the cumulative loading limits, simply multiply the cumulative limit for each parameter by 0.25. In the case of nickel, the result is 105 ppm. The allowable cumulative metal loading would be reached in four applications at this rate.

2. Determine which Contaminant will be the Limiting Factor.

After calculating the metal loading that will be applied (in kg/ha), determine which contaminant will be the limiting factor. This is accomplished by dividing the cumulative loading that will be applied by the concentration of the contaminant in the compost and determining which ratio is the smallest, as demonstrated below.

Example: Application loading restricted to 25 percent of the cumulative loading limits and the following hypothetical contaminant concentrations:

Parameter	Application Loading Limited to 25% Cumulative	Hypothetical Concentration of Contaminant	Ratio
Arsenic	10.25 kg/ha	3 ppm	3.4
Cadmium	5	1	5.0
Chromium	750	500	1.5
Copper	**375**	**750**	**0.50**
Lead	75	70	1.1
Mercury	4.25	2	2.1
Molybdenum	4.5	5	0.9
Nickel	105	200	0.52
Selenium	25	5	5.0
Zinc	700	600	1.2

The Ratio column is calculated by dividing the Cumulative Loading Limit value by the Hypothetical Concentration of Contaminant column. The lowest ratio will be the limiting factor. In this example copper will limit the amount of compost that can be applied without exceeding 25 percent of the cumulative loading limits in a single application.

3. Calculate the Dry Weight of Compost that may be Applied.

To determine the weight of compost that can be applied, simply multiply the ratio calculated above (kg/ha) by 1,000 to convert into MT/ha.

Example: 0.50 (limiting factor ratio) x 1,000 = 500 dry MT/ha/application

In this example, 500 Dry MT/ha of this compost product may be applied and the amount of copper added to the land will be 25 percent of the cumulative loading limit. The other metals will have been loaded at rates less than 25 percent of the allowable Cumulative Loading Limits.

4. Alternate Approaches to Applications Greater than 200 MT/ha/yr

If a JHD wishes to take a different approach, for example a processor wishes to apply a known weight of material to a given area, the same basic equation is used for all calculations:

Cumulative Loading = Dry Weight x Concentration of Contaminant in Compost

Based on the metal levels of the compost product, the site life can be calculated based on the desired application rate as follows:

$$\text{Site Life} = (\text{Cumulative Loading}) \times \frac{(\text{ha x application})}{\text{kg compost}} \times \frac{\text{kg compost}}{\text{mg contaminant}}$$

Care should be exercised to ensure that the allowable cumulative loads are not exceeded. For additional guidance on the calculations presented in this appendix, contact the Ecology regional office in your area.

E. Allowable Concentration Limits for Cadmium (Cd)

The cadmium limit in Grade AA compost deviates from the approach used in developing other contaminant limits for Grade AA compost for several reasons:

- Cd is a known bioaccumulator.
- U.S. Department of Agriculture's (USDA's) position that EPA's risk assessment incorrectly considered the direct ingestion pathway as the most limiting pathway, rather than the plant uptake pathway.
- USDA's position that EPA incorrectly used a geometric mean rather than an arithmetic mean in determining the limit for Cd.
- USDA's position that Cd concentration in biosolids should be restricted to 21 ppm (reduced from the 39 ppm in part 503, the level currently adopted for Grade A compost).
- U.S. Food and Drug Administration (FDA) concerns that land-applied biosolids should not exceed the 25 ppm Cd limit recommended in the 1981 FDA-USDA Joint Policy Statement.

In light of this controversy, the allowable concentration for cadmium in Grade AA compost is based on the cumulative loading limits prescribed by 40 CFR 257, "Criteria for Classification of Solid Waste Disposal Facilities and Practices". 40 CFR 257 sets cumulative loading limits for cadmium in waste materials that are applied to food chain crops. Because compost is made from many sources that are separated out from the solid waste stream, this is an appropriate application of 40 CFR 257. The level of 10 ppm is based on the following assumptions:

1. a cumulative loading limit of 20 kg/ha, per 40 CFR 257.3 (a)(1)(iii)(A);

2. a cation exchange capacity of > 15 meq/100g;

3. a pH of 6.0-8.0; and

4. an application rate of 200 Metric Tonnes, per hectare, per year; and

5. a site life of 10 applications.

The equation used in making this calculation, is as follows:

$$\text{Concentration (mg/kg)} = \frac{\text{Cumulative Loading (kg/ha)}}{\text{(kg of Compost x Number of Apps)}} \times (10^6 \text{ mg/kg})^*$$

Example:

$$10 \text{ ppm} = \frac{(20 \text{ kg/ha})}{(200{,}000 \text{ kg/ha/application x 10 applications})} \times (10^6 \text{ mg/kg})$$

APPENDIX III: TOTAL PETROLEUM HYDROCARBONS AND ADDITIONAL RECOMMENDED ORGANIC CHEMICAL ANALYSES

TOTAL PETROLEUM HYDROCARBONS

Total Petroleum Hydrocarbons (TPH) are an indication that petroleum contaminated soils (PCS) may have been introduced into the composting process. However, testing for TPH in the final compost may result in false positive results due to natural oil hydrocarbons from organic feedstock. Therefore, Ecology encourages the JHD to require testing for TPH of compost feedstock soil or vactor waste solids that are likely to be contaminated with petroleum hydrocarbons or blended with a finished compost product. Testing procedures and suggested limits are outlined in the Testing Procedures and Quality Assurance Project Plan for the Interim Guidelines for Compost Quality, Appendix VI.

Those PCS which do not fall into the "dangerous waste" category, as defined by chapter 173-303 WAC are considered "problem wastes" under the Minimum Functional Standards (MFS) for Solid Waste Handling, chapter 173-304 WAC. The MFS does not outline specific treatment or disposal standards for problem wastes. **Ecology's policy is that any PCS with concentrations at or above the Model Toxics Control Act (MTCA) Method A cleanup standards (the TPH thresholds listed in Table 3 of the Guidelines) are to be regulated as solid wastes.** County Health Departments are responsible for any necessary solid waste permitting of PCS sites.

Where TPH have been detected, but are below the thresholds identified in Table 3 of these Guidelines (taken from the MTCA Method A cleanup standards), Ecology recommends that these materials not be used in or adjacent to: wetlands, surface water, ground water, drinking water wells or utility trenches, or residential soils. For further guidance on PCS and TPH, consult the Ecology document, Guidance for Remediation of Releases from Underground Storage Tanks, Publication Number 91-30, July, 1991, or contact the Ecology regional office in your area.

ADDITIONAL RECOMMENDED ORGANIC CHEMICAL ANALYSES

There are numerous organic compounds that may be found in compost but are not included in the Guidelines because scientifically established data on which to base levels of safety is not available. Due to the uncertainty of risk, however, it is recommended that some organic compounds be tested for and monitored. We recommend that organic screening tests be conducted that analyze for groups of compounds at one time. If the screening tests reveal compounds at atypical or unexpected levels, more specific tests should then be conducted to determine the precise contaminant of concern. As always, the JHD has the authority to require more or less testing based on the unique feedstocks and processes employed by a facility.

Unfortunately, Ecology cannot at this time provide contaminant thresholds for organic compounds (except for chlordane and pentachlorophenol, as explained in this appendix). Ecology plans to promote and compile research in this area during the interim period.

ORGANIC COMPOUND TESTING FOR TYPE 1 and 2 FACILITIES

It is recommended that Type 1 and 2 facilities test their products using organic screening tests. Testing should be conducted during the time of year that pesticides would most likely be found (April through September).

The following organic screening tests are recommended for Type 1 and 2 facilities:

ORGANO-PHOSPHORUS PESTICIDES SW 846 Method 8141
CHLOROPHENOXY HERBICIDES SW 846 Method 8150
ORGANO-CHLORINE PESTICIDES/PCBS SW 846 Method 8081

The screening test for organo-chlorine pesticides can detect chlordane. The chlorophenoxy herbicides test may be used to test for PCP. Ecology recommends a final compost product limit of 0.3 ppm for chlordane and 0.5 ppm for PCP, based on research conducted by Antech Laboratories in conjunction with Portland METRO's ongoing study to determine contamination limits for yard waste compost. When samples are sent to the lab, the sampler needs to specify pentachlorophenol as a target analyt in the SW846 Method 8150 analysis.

For Type 1 facilities processing less than 10,000 dry metric tons per year (MTPY) of feedstock, only chlordane and pentachlorophenol (PCP) tests are recommended.

Chlordane was used widely in this country for pest control, though it has been banned for all commercial use since 1988. Pentachlorophenol (PCP) is used extensively for treating wood. PCP is more likely to be present if a significant amount of wood waste is included in the feedstock.

ORGANIC COMPOUND TESTING FOR TYPE 3 FACILITIES

Because of the heterogeneity of the Type 3 feedstocks we recommend the following tests be conducted throughout the testing schedule determined by the JHD. JHDs are encouraged to consult with Ecology for additional organic parameters.

BASE/NEUTRAL ACID EXTRACTABLE ORGANICS (BNA's) SW 846 Method 8270
ORGANO-PHOSPHORUS PESTICIDES SW 846 Method 8141
CHLOROPHENOXY HERBICIDES SW 846 Method 8150
ORGANO-CHLORINE PESTICIDES/PCBS SW 846 Method 8081
VOLATILE ORGANICS (VOA's) SW 846 Method 8240

APPENDIX IV: STABILITY

Several methods for evaluating compost stability have appeared in recent literature. However, experts agree that there is no single best method. Currently, seed germination tests and various methods of respirometry are most commonly used in the industry. Another test, the Dewar Self-Heating Test, evaluates reheating potential in compost. This bench-scale test is used in other states, and is being explored by Ecology.

This appendix outlines the procedures for the cress seed germination test. It also includes procedures to test the reduction of organic matter. Reduction of organic matter is not recommended as an indicator of stability by itself, but may give beneficial information about the compost when used in conjunction with other test methods.

In addition to the methods provided, the Clean Washington Center commissioned a study by E&A Environmental Consultants, Inc., June 30, 1993. The final report (Report Number B15), "A Protocol for Assessing Compost Stability in the Field: Development, Evaluation and Feasibility," describes other methods which can be used to evaluate the stability of compost products without laboratory analysis.

Cress Seed Germination and Root Elongation Bioassay

This method has been adapted from the Clean Washington Center study cited above, and Grebus, M. 1992 M.S. Thesis, Ohio State University. This method is still under development and has not yet been standardized nor results calibrated extensively. A higher Germination Index value indicates a compost extract quality closer to the control (i.e. seeds germinated in deionized water). Some preliminary findings suggest that there may be mild phytotoxicity associated with Germination Index values of between 30 to 60 when the final volume of compost exceeds 30 percent of the final growth medium. The robustness and validity of this method should be verified or discounted as more test data is created and analysis performed in the next few years.

Overview

This test procedure entails the following steps:

- Production of compost water extract
- Germination of water cress seeds in the extract and a distilled water control.
- Determination of number of seeds germinated and length of root growth.
- Expression of seed germination and root elongation for each treatment as a percent of the control.

Preparation of the compost: water extract takes several hours. Consequently, the test procedure should begin in the morning.

Methodology

Preparation of a compost/water extract

1. Place a 30 gram sample of compost into a 250 ml flask.

2. Add an appropriate volume of water to the flask to make a 10 percent (weight:volume) compost:water extract.

3. Using a magnetic stirrer, mix the compost/water extract for 10 minutes at high speed.

4. Allow the compost/water mixture to settle for 30 to 60 minutes.

5. Set up a large funnel with fast filter paper in an empty 250 ml flask. Decant the aqueous portion of the mixture into the funnel in order to remove solid and suspended particles.

6. Repeat the filter procedure using slow filter paper. This step can take several hours. After approximately 50 ml of filtrate have passed through the filter, proceed to the next step.

7. Using a vacuum pump, pull the filtrate through a 0.45 micron, sterile filter unit (Thomas Scientific Cat. #-4619B45).

8. Mix 10 ml of the filtrate with 10 ml of deionized water to produce a 5 percent compost:water extract.

Bioassay Preparation

1. For each compost sample, prepare three germination units by placing a 7.5 cm piece of filter paper (Thomas Scientific Cat. #-4704H10) into a 9 cm diameter, plastic petri dish.

2. Using a pipette, transfer 2 ml of the compost/water extract into a filter paper lined petri dish. Repeat twice for a total of three replicates.

3. Prepare a control by substituting distilled water for the compost/water extract. Also use three replicates for the control.

4. Place ten water cress seeds into each petri dish. The water cress seeds should be stored in a refrigerated airtight container. The seed supplier is:

Liberty Seed Company
P.O. Box 806
New Philadelphia, Ohio 44663
(216) 364-1611
Ask for seed lot 4935. Orders can be made over the phone.

5. Secure the petri dish lids with a strip of parafilm. This step is necessary to prevent the water extract from evaporating.

6. Incubate the petri plates for 40 hours at 30°C.

7. After the incubation period stop root growth by adding 1 ml of 50 percent methanol to each petri dish. Count the number of seeds germinated in each dish and measure the root length of each germinated seed. Record data.

8. Calculate the percent germination by dividing the mean percent germination of each treatment by the mean of the control. Calculate the percent root length by dividing the mean root length in cm (ungerminated = 0 cm) of each treatment by the mean root length of the control. The Germination index is calculated for each treatment by multiplying the percent germination by the percent root length and then dividing the product by 100.

Reduction of Organic Matter

The percent reduction of organic matter (ROM) is a measure of the loss of decomposable material compared to the amount present prior to composting. To make this comparison, test input and output samples for % volatile solids (VS) according to SM18 2540 E. The method of calculation assumes that the percent organic matter equals percent volatile solids (% VS = % OM).
Note in the graph on the next page that the amount of ash remains constant over the course of composting.

Careful sampling is critical to the validity of this test. Input samples should be taken immediately after feedstock materials are formed into compost piles. Finished samples should be taken <u>before</u> screening to include all particle sizes in the sample.

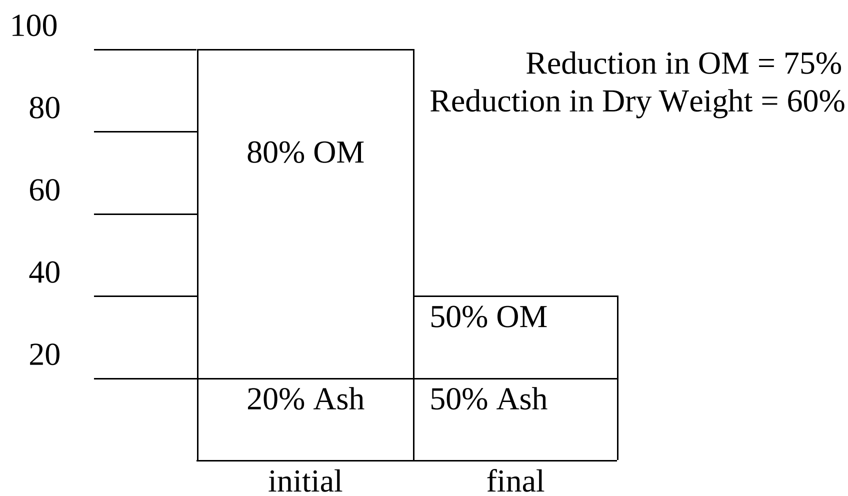
Calculate the percent reduction of organic matter using % volatile solids (VS) test results and the following formula:

Calculation of % ROM

$$\% \text{ ROM} = 1 - \frac{\dfrac{\% \text{ Ash}_{initial}}{\% \text{ Ash}_{final}} \times \% \text{ OM}_{final}}{\% \text{ OM}_{initial}} \times 100$$

where ROM means the reduction in organic matter;
OM means organic matter (assumed to be equal to volatile solids);
Ash means the weight of residue left after ignition of sample

The diagram below gives example sample weights in grams (dry weight) and relative percents of OM and Ash.



ROM diagram and equation from Woods End Research Laboratory, Inc. Mount Vernon, ME.

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APPENDIX VI: TESTING PROCEDURES AND QUALITY ASSURANCE PROJECT PLAN

A complete QA project plan should include the following sections:

1.0 ORGANIZATION AND RESPONSIBILITIES

The purpose of this section is to identify everyone responsible for oversight and implementation of the compost testing and monitoring project. Include the names, addresses and phone numbers of facility staff, laboratory contacts, JHD staff and anyone else who may need to be contacted in the course of testing and monitoring the compost product. Also list the responsibilities of each individual.

1.1 Title Page

The title page identifies the document and the facility to which it applies, shows the date of preparation or revision, and provides space for approval signatures. It should include:

1. Facility name and address
2. Facility permit number
3. Date of preparation or most recent revision
4. Approval signatures as required by the JHD

1.2 Description

The description section provides the background information relevant to the monitoring project and should include the following:

Feedstocks: A brief description of the feedstocks the facility is permitted to receive

Compost Process: A brief description of the composting process used at the facility, including equipment types

Product Piles: A description of the processes used to create and maintain the storage piles of compost product

Objectives: A description of the purpose of the compost monitoring project

For example: The objective of compost monitoring is to demonstrate that our product complies with federal, state and local regulations by collecting a representative sample of the product and analyzing it for the parameters regulated in the facility permit.

Schedule: A list of the compost monitoring schedule testing frequency for the facility

Historical Data: A summary of previous data on the compost product

2.0 DATA QUALITY OBJECTIVES

The following paragraphs briefly discuss concepts and terminology common to data quality analysis. This includes types of errors, measurement limitations, precision and bias of data.

All measurements are subject to random and systematic errors. Random error associated with the results of analytical measurements is measured by precision. Precision is often estimated by the relative percent difference (RPD) between duplicate measurements. The RPD generally becomes smaller as the concentration of the contaminant or parameter being measured increases. In general, very low concentrations tend to yield less precise data.

Bias is a measure of the systematic error associated with the results of analytical measurements. The presence of bias is indicated by the percent recovery achieved for a reference (chemically known) materials and spiked samples tested at the same time as the samples.

The laboratory will establish lower reporting limits (LRL) for each parameter in the compost matrix. The LRL is typically higher than the detection limit and is established to ensure reasonable precision for even the lowest results reported. Positive results which are below the LRL are reported as less than the LRL to avoid reporting imprecise data.

If possible, the data quality objective for the lower reporting limit should be no greater than one-fifth of the regulatory limit for the parameter. This will ensure that the precision of results at the regulatory limit will be adequate to allow a determination of compliance with the limit.

The data quality objectives should include a table listing for each parameter, the method to be used, the quantity of sample required, the minimum acceptable reporting limit and, if possible, the expected concentration range for the samples. The information on expected concentrations is very important to help the analyst select a calibration range or sample dilution factor and to avoid cross-contamination from high level samples.

If the concentration of a contaminant is close to the regulatory limit, greater precision may be required in order to determine whether the limit is being exceeded. This may necessitate the collection and analysis of replicate samples.

3.0 ON-SITE MEASUREMENTS

Describe procedures for any on-site measurements such as temperature or moisture content which will be made as part of the compost monitoring process.

4.0 SAMPLING PROCEDURES

If a single composite sample is to be representative of a large pile of product, the sampler must exercise care and good judgement in the collection and preparation of that sample. Based on the procedures used to create the product pile, describe a feasible sampling protocol which is likely to yield a composite sample which represents the entire product pile.

As a guideline, five to ten samples taken from one- to three-feet deep in the pile and from various parts of the pile should suffice. These samples must be thoroughly mixed in a large container to provide a representative sample of the pile. The total amount of sample required is determined by the analyses requested. Determine the size of the sample to be sent to the lab by conferring with laboratory staff <u>before</u> the first scheduled sampling event.

List the sampling equipment to be used and where and how it is to be stored. This should be dedicated equipment which is not used for any other purpose. Stainless steel equipment is recommended, however plastic equipment may be used for samples which are not analyzed for organic compounds. Also, describe the procedures to be used to clean the sampling equipment.

The following references discuss various approaches to sampling solid materials:

> ASTM Method D 2944
> SW846, Chapter 9

List the sample containers to be used and the procedures for obtaining and storing them. The laboratory may be able to supply pre-cleaned sample containers to the facility.

Include a copy of a sample label with all necessary information filled in. Describe the protocol for identifying the samples. At a minimum, the sample label should include the name of the facility, the date and time the sample was collected, a unique sample identifier, and the parameters to be determined.

Describe the protocols for maintaining a bound sample log book which should contain at least the following information:

1. Facility name
2. Laboratory name(s)
3. Sampling date and time
4. Compost batch number
5. Tests required

6. Name of sampler

Describe the sample chain-of-custody procedures to be followed. These will normally include a chain-of-custody form to be prepared by the sampler and signed by each person who takes control of the sample. The laboratory may offer a pre-printed analytical request form with a chain-of-custody section.

Describe the procedures for shipping the sample to the laboratory. Make sure that the shipping containers are acceptable to the proposed carrier. For example, some carriers will not accept containers with loose ice inside.

5.0 ANALYTICAL PROCEDURES

Since the methods in EPA's solid waste manual, SW846, are not specifically intended for compost, a detailed procedure for sample preparation must be included in the project plan. This procedure should be developed in consultation with the laboratory.

One procedure which has been used for trace metals analysis involves drying the sample at 60 °C for 24 hours (or to constant weight), then grinding the dry sample in a Wiley Mill to < 0.5 mm (35 mesh). Grinding with a mortar and pestle is another option.

The guiding principle is that the sample taken for analysis must be several times the size of the largest particle in the sample matrix. A small sample volume relative to the average compost particle size, will not be representative of the compost.

The laboratory should be sent a backup sample, in case the first sample is lost or damaged.

Describe the requirements for reporting the analytical results. Specify the maximum time for delivery of the results. Other requirements may include reporting on a dry weight basis, the desired units, and complete reporting of calibration and QC data associated with the sample. A case narrative including a review of the results and the QC data associated with them should be required.

6.0 QUALITY CONTROL PROCEDURES

The accuracy of a measurement cannot be determined from the measurement itself. Quality Control (QC) procedures provide the information necessary to estimate the accuracy of the associated results.

6.1 Field QC procedures include:

Field blanks to indicate contamination in containers and sampling equipment.

Replicate samples of the same compost sample are sent for analysis to provide an estimate of random error due to sampling and analysis (total precision).

Reference materials of known chemical composition are submitted blind to the lab to check on the accuracy of the results.

In most cases, facilities will not be required to submit field QC samples.

6.2 Laboratory QC procedures include:

Method blanks to indicate contamination in the laboratory.

Check standards prepared independently of the calibration standards and used to estimate analytical precision and to indicate bias in the measurements due to calibration or sample preparation.

Analytical duplicates to provide an estimate of random error due to analysis (analytical precision).

Spiked samples to indicate bias due to matrix interference.

Most of the analytical methods include adequate requirements for laboratory QC procedures. A statement to that effect should be included in the QA plan. The facility has the right to request additional QC procedures if necessary.

7.0 DATA ASSESSMENT AND REPORTING

It is important to have a clear understanding of what is to be done with the results from the compost monitoring project. All compost monitoring results should be reported to the JHD.

The Ecology EILS program has agreed to establish a statewide data base of Washington compost facility test results to be used in updating these guidelines. Participation is requested in this voluntary program and the data collected can be protected under Ecology's confidentiality statute, RCW 43.21A.160. Requests for confidentiality should be made in writing to Ecology, Public Disclosure Officer, at headquarters.

Compost Report Confidentiality Request
Public Disclosure Officer
Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

Test results should be sent to:

Stewart Lombard
Quality Assurance Section
Department of Ecology
PO Box 488
Manchester, WA 98353-0488

Describe the procedures and assign responsibility for compiling and reporting the monitoring results.

The report should include the following:

1. Descriptions of the samples
2. Parameters determined (what was tested in the samples)
3. Methods used to determine each parameter
4. Regulatory limit for each parameter*
5. Measurement results
6. Quality Control sample results
7. Field blank results
8. Field replicate results
9. Method blank results
10. Lab duplicate results
11. Check standard results
12. Matrix spike results*
13. Surrogate spike results*

* where appropriate

When a regulatory limit has been established for a contaminant, that limit is considered to be exceeded if the result of analysis of a sample of the compost equals or exceeds the regulatory limit. If replicate samples are collected and analyzed, the mean of the results is compared with the regulatory limit to determine compliance.

If the true value of a contaminant equals the regulatory limit, there is a 50-50 chance that the result of a single measurement will exceed the limit. Therefore, if a result for <u>a single sample</u> of compost exceeds the regulatory limit by less than 20 percent, three or four additional samples should be collected and analyzed to verify if the mean of those results exceeds the limit.

Because of the inherent variation that naturally occurs between individual sample results, it is important to develop a statistically significant data set early in the operating life of a composting facility. As more samples are taken, the level of statistical confidence in the results will increase and the operator's ability to predict operational results within a certain range of variation from normal will be enhanced. This will assist in identifying when a single or few test results are most likely attributable to a normal variation within a normal operating range or, on the other hand, a significant excursion from normal operations.

Table 5 lists suggested methods for testing various parameters that may be useful in characterizing compost quality.

TABLE 5

COMPOST PARAMETER METHODS

Parameter	Ref.	Method	Sample Required
PHYSICAL CHARACTERISTICS			
Total Solids	SM18	2540G	25 - 50 g
Volatile Solids	SM18	2540G	25 - 50 g
Particle Size	ASTM	2977	20 g
Water Holding Capacity	ASTM	2980	
Conductivity	UWCFR		10 g
pH	SW846	9045	20 g
MATURITY TESTS			
Stability	See Appendix IV		
Seed Germination	ASA		
NUTRIENTS			
Total Kjeldahl Nitrogen	SM18	4500-N org B	
	EPA	351.3	
Ammonia	EPA	350.1	
	SM18	4500-NH_3 B	
Nitrate	ASA	33-8	
Phosphorus	SM18	4500-P	
INORGANICS			
Cation Exchange Capacity	SW846	9081	4 g
Soluble Salts	UWCFR		10 g
INDICATOR BACTERIA			
Fecal Coliform	SM18	9221 B&E	
	See Appendix IX		

TABLE 5 - COMPOST PARAMETER METHODS (Continued)

Parameter	Ref.	Method	Sample Required
Salmonella	To be determined		
<u>METALS</u>			
Sample Prep.	SW846	3050	1 - 2 g
PP Metals	SW846	6010	

Arsenic	Barium	Beryllium
Cadmium	Calcium	Chromium
Copper	Iron	Lead
Magnesium	Manganese	Molybdenum
Nickel	Potassium	Selenium
Silver	Sodium	Zinc

Parameter	Ref.	Method	Sample Required
Mercury	SW846	7471	
<u>ORGANICS</u>			
VOA Sample Prep.	SW846	5030	1 to 5 g
SVO Sample Prep.	SW846	3540	10 g
Extract Cleanup	SW846	3610 3620 3630 3640	
Org.-P Pests.	SW846	8141	

Chlorothion	Chlorpyrophos (Dursban)
Diazinon	Dichlorvos
Malathion	Mevinphos
Parathion-ethyl	Parathion-methyl
TEPP	

TABLE 5 - COMPOST PARAMETER METHODS (Continued)

Parameter	Ref.	Method	Sample Required
Chlorophenoxy Herbicides	SW846	8150	

2,4-D	2,4-DB
2,4,5-T	2,4,5-TP (Silvex)
Dicamba	Dichloroprop
MCPA	MCPP

Parameter	Ref.	Method	Sample Required
Organo-Chlorine Pesticides/PCBs	SW846	8080	

Aldrin	Chlordane
4,4'-DDT	4,4'-DDE
4,4'-DDD	Dieldrin
Endosulfan I	Endosulfan II
Endrin	Heptachlor
Gamma-BHC (Lindane)	Toxaphene
Trichlorphon	Arochlors (PCBs)

Parameter	Ref.	Method	Sample Required
VOAs	SW846	8240	

Acetone	Benzene
Bromoform	2-Butanone
Carbon Tetrachloride	Chloroform
Ethylbenzene	Methylene Chloride
Methylethylketone	Toluene
Trichloroethylene	Trichlorofluoromethane
Vinyl Chloride	o-, m- and p- Xylenes

TABLE 5 - COMPOST PARAMETER METHODS (Continued)

Parameter	Ref.	Method	Sample Required
BNAs (SVOs)	SW846	8270	

Acenaphthene	Aniline
Anthracene	Benzo(a)anthracene
Benzo(a)pyrene	Benzyl Alcohol
Benzylbutylphthalate	Bis(2-ethylhexyl)phthalate
Chrysene	1,2-Dichlorobenzene
1,4-Dichlorobenzene	Diethylphthalate
Dimethylphthalate	Di-n-butylphthalate
Di-n-octylphthalate	Fluoranthene
Fluorene	Hexachlorobenzene
Hexachlorobutadiene	2-Methylnaphthalene
4-Methylphenol	Naphthalene
N-Nitrosodimethylamine	Pentachlorophenol
Phenanthrene	Phenol
Pyrene	Styrene
2,4,5-; 2,4,6-Trichlorophenol	

DIOXINS/FURANS

Parameter	Ref.	Method	Sample Required
Dibenzofurans	SW846	8280	
TOC	SW846	9060	

TPH (Test for soil and vactor waste solids feedstock that may be contaminated)

Parameter	Ref.	Method	Sample Required
Total Petroleum Hydrocarbons	Guidance for Remediation of Releases From Underground Storage Tanks, Ecology #91-30, Appendix L, Toxics Cleanup Program	WTPH-HCID (Screening)	10g
		WTPH-G (Gasoline)	10g
		WTPH-D (Diesel)	10g
		WTPH-418.1 (Heavy Oil)	10g

COMPOST PARAMETER METHOD AND LAB TECHNICAL ABBREVIATIONS

ASTM American Society of Testing and Materials, 1990 Annual Book of ASTM Standards, Section 11, Water and Environmental Technology, Philadelphia, PA, 1990.

UWCFR University of Washington College of Forest Resources, In Compost Testing Procedures Manual for the State of Washington Dept. of Ecology, 1991.

SW846 U.S. Environmental Protection Agency, Office of Solid Waste, Test Methods for Evaluating Solid Waste, 3rd Ed.

ASA American Society of Agronomy, Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties, 2nd Ed.

SM18 American Public Health Association, et. al., Standard Methods for the Examination of Water and Wastewater, 18th Ed., 1992.

B&E SM18 Method Numbers, e.g. 9221 B&E.

MPN Most Probable Number method for fecal coliform.

ICP/AES Inductively Coupled Plasma Atomic Emission Spectrometry.

PP Priority Pollutant.

CVAA Cold Vapor Atomic Absorption Spectrometry.

VOA Volatile Organics Analysis.

SVOs Semi-Volatile Organics.

Org.-P Pests. Organo-phosphorus Pesticides

Extr. Extraction.

Cap. Capillary.

GC/FPD Gas Chromatography with Flame Photometric Detector.

GC/ECD Gas Chromatography with Electron Capture Detector.

MCPA 4-Chloro-2-methylphenoxy acetic acid.

MCPP 2-(4-Chloro-2-methylphenoxy) propionic acid.

GC/HSD	Gas Chromatography with Halogen Specific Detector.
PCBs	Polychlorinated Biphenyls.
GC/MS	Gas Chromatography with Mass Spectrometric Detector.
BNAs	Base-Neutral/Acid Extractable Organics (Same as SVOs).
GPC	Gel Permeation Chromatography.
ND	Not Determined.
TOC	Total Organic Carbon.
DI	Deionized.
WTPH	Washington Total Petroleum Hydrocarbon
HCID	Hydrocarbon Identification Method

APPENDIX VII ACRONYMS AND ABBREVIATIONS

Acronyms or Abbreviation	Meaning
CFR	Code of Federal Regulations
cm^3	cubic centimeters
EPA	Environmental Protection Agency
ft^3	cubic feet
g	grams
Guidelines	Interim Guidelines for Compost Quality
ha	hectare (2.471 acres)
JHD	jurisdictional health department or district
kg	kilograms
lb	pounds
MFS	Minimum Functional Standards for Solid Waste Handling
MT	Metric Tonne (2204.6 pounds)
MTPY	metric tonnes per year
PCS	petroleum contaminated soils
QA	Quality Assurance
QC	Quality Control
RCW	Revised Code of Washington
USDA	U.S. Department of Agriculture
WAC	Washington Administrative Code
yd^3	cubic yards
yr	year

APPENDIX VIII EXAMPLES OF COMPOST QUALITY FROM OTHER COUNTRIES AND STATES

The following pages contain information regarding the chemical analysis, nutrients, and contaminants of compost made from different feedstocks in different locations. These selected tables have been excerpted from Massachusetts Department of Environmental Protection, Contaminants for Regulation (Chapter 2) by E&A Environmental Consultants, Inc., May 29, 1992.

TABLE 1.2-1 - CHEMICAL COMPOSITION OF SEWAGE SLUDGE COMPOST FROM VARIOUS LOCATIONS

Nutrient Composition of Sewage Sludge Composts

SOURCE	OM	C	N	C:N	P	K	Ca	Mg	pH	COND
	%									
Fort Collins, CO		18.5	1.94	9.5	1.61	0.25	2.70	0.30	5.4	4.4
Akron, OH		23.5	2.57	9.1	0.22	0.08	1.60	0.05		0.8
Plattsburg, NY	82	45.9	2.50	18.4	0.27	0.10				
Portland, OR	60	33.3	1.81	18.4	1.79	0.25	1.01	0.23	4.7	0.5
Sarasota, FL			2.20		0.88	0.15				
Schenectady, NY									7.2	
Greenwhich, CT			1.21		0.01	0.01			6.7	
Hampton Roads, VA	49	27.4	1.80	15.2	2.30	0.20	1.46	0.34	6.4	
Columbus, OH	48	26.9	1.25	21.5	3.45					
Blue Plains, MD		13.0	0.90	14.4	1.00	0.10	2.00	0.30	6.8	
Number of Samples	4	7	9	7	9	8	5	5	6	3
Average	59.75	26.93	1.80	15.21	1.28	0.14	1.75	0.24	6.20	1.90
Standard Deviation	13.68	9.84	0.55	4.32	1.06	0.08	0.57	0.10	0.87	1.77
Maximum Value	82.00	45.90	2.57	21.50	3.45	0.25	2.70	0.34	7.20	4.40
Minimum Value	48.00	13.00	0.90	9.10	0.01	0.01	1.01	0.05	4.70	0.50

Micro-nutrient and Metal Content of Sewage Sludge Compost

SOURCE	Na	Fe	Zn	Cu	Mn	Cd	As	Cr	Pb	Hg	Ni	B
	%						ppm					
Fort Collins, CO	0.02	1.20	1039	642	192	14.0		86	214		25	16
Akron, OH			505	210		9.4	7.8	27	145	0.49	31	
Plattsburg, NY			156	167		1.6		17	26	0.36	11	
Portland, OR	0.03	1.37	1368	485	338	26.2		288	384		126	0.9
Sarasota, FL			281	210		1.7		73	20		6	
Schenectady, NY			141	141		4.9		36	42	0.42	9.4	
Greenwhich, CT			180	119		6.0	2.2	22	12	12.6	6.9	
Hampton Roads, VA		2.12	809	361		8.0		96	150		33	
Columbus, OH			1800	250		19.0		265	265		113	
Blue Plains, MD			1000	250		9.0			320			27
Number of Samples	2	3	10	10	2	10	2	9	10	4	9	3
Average	0.03	1.56	728	284	265	10.0	5.0	101	158	3.5	40.1	14.6
Standard Deviation	0.01	0.40	544	158	73	7.4	2.8	98	128	5.3	43.6	10.7
Maximum Value	0.03	2.12	1800	642	338	26.2	7.8	288	384	12.6	126	27
Minimum Value	0.02	1.20	141	119	192	1.6	2.2	17	12	0.4	6.0	0.9

Note:

All nutrient and metal concentrations reported on a dry weight basis, percent (%) or parts per million (ppm) as indicated.

OM = organic matter
COND = conductivity (μmho/cm)

TABLE 1.2-2 - CHEMICAL COMPOSITION OF MUNICIPAL SOLID WASTE COMPOST FROM VARIOUS LOCATIONS

Nutrient Composition of Municipal Solid Waste Composts

SOURCE	OM	C	N	C:N	P	K	Ca	Mg	pH	COND
	%									
Pistoia, Italy	46	26.2	1.30	20.0	0.30	0.90			8	
Sevilla, Spain	49	27.4	1.40	19.6	0.60	0.70	7.50	0.50		
Puerto Real, Spain	39	21.7	1.00	21.7	0.40	0.30	5.50	0.20		
Granada, Spain	44	24.6	1.50	16.4	0.20	0.60	8.50	1.00		
France			0.90		0.30	0.30	4.00	0.40		
Netherlands			0.96		0.33	0.27	2.13	0.22		
Gainesville, FL		33.8	0.51	66.3	0.15	0.14	1.20	0.08		
Prumerend, Holland	40	22.2	1.38	16.1	0.35	0.79	5.00	4.30		
Brainerd, MN							3.00	0.69		
Switzerland	43	23.0	1.00	23.0	0.40	0.30	4.00	0.40		
Thief River Falls, MN		14.6	0.90	16.2	0.28	0.22	4.02	0.71	7.6	6.5
Kruchtal, Switz.		20.4	1.62	12.8	0.25	0.65	3.53	0.51	8.1	3.2
Schaffausen, Switz.		19.3	1.38	14.0	0.69	0.49	5.81	0.42	7.8	5.2
Fillmore County, MN			1.08		0.35	0.76	7.60	0.58	6.8	10
Dade County, FL										12
Dodge County, KS			0.61		0.6	0.43	7.5	0.11		
Number of Samples	6	10	14	10	14	14	14	14	5	4
Average	43.30	23.32	1.11	22.61	0.37	0.49	4.95	0.72	7.66	6.23
Standard Deviation	3.41	4.91	0.32	14.89	0.15	0.23	2.14	1.02	0.46	2.48
Maximum Value	49.00	33.80	1.62	66.30	0.69	0.90	8.50	4.30	8.10	10.00
Minimum Value	38.80	14.60	0.51	12.80	0.15	0.14	1.20	0.08	6.80	3.20

Micro-nutrient and Heavy Metal Content of Municipal Solid Waste Composts

SOURCE	S	Na	Fe	Al	Zn	Cn	Mn	Cd	As	Cr	Pb	Hg	Ni	B
	%				ppm									
Pistoia, Italy					700	340		11		112	370		47	
Sevilla, Spain	0.20		0.22		700	200	500	0.04		1.5	8.7		0.8	3
Puerto Real, Spain	0.30		0.13		4000	180	1250	0.09		2.1	12.4		1.1	15
Granada, Spain	0.50		0.34		500	200	1100	0.09		1.8	10.8		0.8	
France	0.60	0.30			1000	250	600	7		270	600	4	190	60
Netherlands	0.32	0.30			1650	630	400	6	9	220	900	5	110	60
Gainesville, FL	0.20	0.20			500	200	300	100						
Prumerend, Holland					175	32		0.7		55	54		12	
Brainerd, MN			0.61		320	54	272	6.4	4.1	93	148	0.7	65	
Switzerland					2200	715		11		179	1460	7	9	30
Thief River Falls, MN	0.76	0.38	0.58	0.53	580	333	405	4		22	390		21	38
Kruchtal, Switz.	0.27	0.19	0.68	1.12	646	90	662	2		36	286		24	32
Schaffausen, Switz.	0.39	0.28	1.16	1.12	1430	1090	523	2		58	395		20	50
Fillmore County, MN	0.49	0.47	1.32	0.54	1010	190	340	4.8	1.1	56	913	3.7	32.8	5
Dade County, FL					607	246		4.1	3.7	21	124	2.4	34	
Dodge County, KS					350	133		1		27	350			
Number of Samples	10	7	8	4	16	16	11	16	4	15	15	6	14	9
Average	0.40	0.30	0.63	0.83	1023	305	577	10.01	4.48	76.96	401	3.80	40.54	32.56
Standard Deviation	0.17	0.09	0.40	0.29	927	271	306	23.49	2.86	80.90	401	1.97	50.36	20.52
Maximum Value	0.76	0.47	1.32	1.12	4000	1090	1250	100	9	270	1460	7	190	60
Minimum Value	0.20	0.19	0.13	0.53	175	32	272	0.04	1.10	1.50	8.70	0.70	0.80	3.00

TABLE 1.2-3 - CHEMICAL COMPOSITION OF MUNICIPAL SOLID WASTE COMPOST FROM VARIOUS LOCATIONS

Nutrient Composition of Co-Composts

SOURCE	C	N	C:N	P	K	Ca	Mg	pH	COND
	%			%					
Blauerban, Germ.	27.1	1.18	23.0	0.37	0.20	6.37	0.40		
Leicester, Eng.		1.45		0.34	0.51	4.06		7.4	
Johnson City, TN	21.2	0.94	22.6	0.32	0.17	1.98	0.44		
St. Cloud, MN	24.5	1.25	20.2	0.35	0.90	6.55	0.31	6.7	4.6
Lodi, WI	23.1	1.62	14.2	0.45	0.56	3.82	0.50	8.0	4.6
Wilmington, DE	34.9	1.55	21.8	0.54	0.22	1.73	0.24	7.4	6.7
Gladewater, TX	12.3	0.84	15.4	0.71	0.20	1.20	0.11	7.1	1.9
Fallkenberg, Swed.	31.1	2.06	14.8	0.48	0.94	3.63	0.29	7.3	8.1
Borlange, Swed.	21.1	1.74	12.4	0.70	0.44	2.81	0.22	7.2	5.8
Frederikssund, Den.	20.9	1.75	11.6	0.53	0.73	3.49	0.33	6.8	8.0
Leeds, Eng.	18.8	1.24	15.7	0.62	0.15	3.72	0.26	7.3	1.7
Dusslingen, Germ.	32.1	2.00	16.0	0.34	0.90	4.57	0.42	7.5	7.9
Toronto, Can.	24.5	1.20	20.4	0.46	0.28	4.31	0.47	7.8	3.7
Number of Samples	12	13	12	13	13	13	12	11	10
Average	24.30	1.45	17.34	0.48	0.48	3.71	0.33	7.32	5.30
Standard Deviation	6.02	0.37	3.86	0.13	0.29	1.53	0.11	0.36	2.28
Maximum Value	34.9	2.06	23.0	0.71	0.94	6.55	0.5	8	8.1
Minimum Value	12.3	0.84	11.6	0.32	0.15	1.20	0.11	6.7	1.7

Micro-nutrient and Heavy Metal Content of Co-Composts

SOURCE	S	Na	Fe	Al	Zn	Cu	Mn	Cd	Cr	Pb	Hg	Ni	B
			%				ppm						
Blauerban, Germ.		0.12	0.25		590	257	520			6.3		20	277
Leicester, Eng.			1.65		160	280		6		580		100	
Johnson City, TN		0.27	0.24		776	370	418			4.8	0.2	24	321
St. Cloud, MN	0.65	0.53	0.94	1.26	568	224	344	3	58	220		31	63
Lodi, WI	0.61	0.52	0.71	1.83	989	267	623	8	74	660		28	66
Wilmington, DE	0.71	0.27	0.47	0.98	802	208	369	5	185	573		197	40
Gladewater, TX	0.26	0.12	1.09	0.73	502	104	218	6	69	185		15	12
Fallkenberg, Swed.	0.55	0.64	0.65	1.05	1370	293	550	3	93	554		51	43
Borlange, Swed.	0.52	0.38	1.61	1.51	2420	985	1370	8	56	1620		68	47
Frederikssund, Den.	0.63	0.74	0.86	1.37	1410	394	980	3	139	423		80	59
Leeds, Eng.	0.46	0.89	1.10		972	174	666	4	83	588		43	43
Dusslingen, Germ.	0.70	0.48	0.59		108	134	543	1	39	682		21	58
Toronto, Can.	0.54	0.57	0.58		1060	514	490	8	98	770		53	60
Number of Samples	10	12	13	7	13	13	12	11	10	13	1	13	12
Average	0.56	0.46	0.83	1.25	902	323	591	5.0	89.4	528	0.2	56.2	90.8
Standard Deviation	0.13	0.23	0.43	0.34	581	219	298	2.3	41.3	399	0.0	47.5	94.6
Maximum Value	0.71	0.89	1.65	1.83	2420	985	1370	8	185	1620	0.2	197	321
Minimum Value	0.26	0.12	0.24	0.73	108	104	218	1	39	4.8	0.2	15	12

TABLE 1.2-4 - CHEMICAL COMPOSITION OF YARD WASTE COMPOST FROM VARIOUS LOCATIONS

Nutrient Composition of Yard Waste Composts

SOURCE	OM	C	N	C:N	P	K	Ca	Mg	pH	COND
		%					%			
Croton Point, NY	22	12.5	0.62	20.2	0.04	1.11	1.84	0.59	8.2	
Florence, Italy	61	35.5	1.90	19.0	0.30	1.50			8.6	
Kruchtal, Switzerland		20.7	1.60	12.8	0.32	0.66	3.53	0.46	7.8	5.2
Schaffhausen, Switz.		21.3	1.60	13.3	0.56	0.62	5.16	0.37	7.3	5.0
Portland, OR	65	35.8	0.63	56.9	0.14	0.62	1.05	0.25	6.7	1.4
Roseville, MN		28.4	1.35	21.2	0.19	0.28	3.68	0.53	7.8	1.4
Garden Hills, MN		20.7	1.32	15.8	0.16	0.27	1.82	0.32	7.4	1.5
Minneapolis, MN		21.9	1.32	16.2	0.16	0.26	4.37	0.83	8.0	1.4
St. Paul, MN		22.1	1.68	14.1	0.24	0.53	3.27	0.45	8.0	2.6
Eden Prairie, MN		16.4	1.09	16.2	0.16	0.21	3.49	0.90	7.9	1.5
Coon Rapids, MN		22.4	1.64	14.1	0.24	0.42	2.25	0.32	7.5	2.8
Forest Lake, MN		15.0	1.02	15.1	0.15	0.32	3.39	0.42	7.8	2.0
Woodbury, MN		17.9	1.50	11.8	0.27	0.54	2.40	0.30	7.6	2.7
Hastings, MN		15.0	1.00	15.0	0.15	0.17	2.39	0.54	7.7	1.1
Golden Valley, MN		13.7	0.57	24.8	0.08	0.06	3.02	0.82	7.8	0.4
Maple Grove, MN		15.6	0.86	18.3	0.12	0.21	2.76	0.49	8.3	1.1
Number of Samples	3	16	16	16	16	16	15	15	16	14
Average	49.30	20.93	1.23	19.05	0.21	0.49	2.96	0.51	7.77	2.15
Standard Deviation	19.07	6.83	0.40	10.32	0.12	0.36	1.02	0.20	0.42	1.37
Maximum Value	64.50	35.83	1.90	56.87	0.56	1.50	5.16	0.90	8.60	5.20
Minimum Value	22.40	12.50	0.57	11.80	0.04	0.06	1.05	0.25	6.70	0.40

Micronutrient and Heavy Metal Composition of Yard Waste Composts

SOURCE	S	Na	Fe	Al	Zn	Cu	Mn	Cd	Cr	Pb	Ni	B
			%					ppm				
Croton Point, NY	0.23	1.51	2.67		82	19	374		11.0	32	10.1	15
Florence, Italy				0.05	105			4.0	32.0	50	31.0	
Kruchtal, Switzerland	0.27	0.25	0.49	0.91	747	115	502	3.0	37.0	377	23.0	30
Schaffhausen, Switz.	0.34	0.23	0.99	0.52	522	126	420	2.0	46.0	237	18.0	42
Portland, OR	0.20	0.02	1.50	0.78	160	25	396	0.8	24.0	73	21.0	0.2
Roseville, MN		0.01	0.20	0.12	94	13	434	0.4	8.0	24	9.4	68
Garden Hills, MN		0.01	0.22	0.18	91	9	393	0.4	7.4	26	7.5	32
Minneapolis, MN		0.01	0.30	0.20	140	13	475	0.6	9.5	91	10.3	76
St. Paul, MN		0.01	0.28	0.20	125	15	349	0.5	8.0	81	8.9	63
Eden Prairie, MN		0.01	0.31	0.18	62	9	456	0.5	4.9	45	6.3	32
Coon Rapids, MN		0.01	0.17	0.15	73	8	416	0.3	3.7	29	6.1	42
Forest Lake, MN		0.05	0.28	0.25	58	9	578	0.4	4.8	30		24
Woodbury, MN		0.01	0.27	0.29	80	8	434	0.5	4.6	22	5.8	26
Hastings, MN		0.01	0.19	0.16	82	9	333	0.4	4.4	57	4.7	26
Golden Valley, MN		0.03	0.32	0.12	132	18	289	0.5	8.9	127	8.9	26
Maple Grove, MN		0.01	0.24	0.14	57	18	322	0.2	5.3	48	5.2	34
Number of Samples	4	15	15	15	16	15	15	15	16	16	15	15
Average	0.26	0.15	0.56	0.28	163	28	411	1.0	13.7	84.3	11.7	35.7
Standard Deviation	0.05	0.37	0.66	0.24	185	37	72	1.1	12.9	92.0	7.6	19.4
Maximum Value	0.34	1.51	2.67	0.91	747	126	578	4	46	377	31	76
Minimum Value	0.20	0.01	0.17	0.05	57	8	289	0.2	3.7	22.0	4.7	0.2

TABLE 1.2-5 - CHEMICAL COMPOSITION OF FOOD WASTE COMPOST FROM VARIOUS LOCATIONS

Nutrient Composition of Food Waste Composts

SOURCE	OM	C	N	C:N	P	K	Ca	Mg	pH
	%				%				
Florence, Italy	61	35.5	1.90	19.0	0.30	1.50			8.6
Amsterdam, Netherlands	64	31.7	1.24	25.6	0.24	0.71	2.34	0.97	
Enzkreis, Germany									15
Asperg, Germany									15
Heidelberg, Germany	43	23.8	1.30	18.3	0.44	0.42			8.2
Gottingen, Germany	22	14.0	1.12	11.8	0.28	1.66	3.43	0.34	8.0
Prumerend, Netherlands	40	22.2	1.38	16.1	0.35	0.79	5.00	4.30	
Number of Samples	5	5	5	5	5	5	3	3	3
Average	46.0	25.4	1.4	18.2	0.3	1.0	3.6	1.9	8.3
Standard Deviation	15.3	7.5	0.3	4.5	0.1	0.5	1.1	1.7	0.2
Maximum Value	64.0	35.5	1.9	25.6	0.4	1.7	5.0	4.3	8.6
Minimum Value	22.0	14.0	1.1	11.8	0.2	0.4	2.3	0.3	8.0

Micro-nutrient and Heavy Metal content of Food Waste Compost

SOURCE	Zn	Cu	Cd	Cr	Pb	Hg	Ni
				ppm			
Florence, Italy	537	105	4.0	32	50		31
Amsterdam, Netherlands	125	27	0.6	14	61		12
Enzkreis, Germany	210	53	0.6	47	82	0.3	28
Asperg, Germany	240	49	0.4	40	42	0.2	22
Heidelberg, Germany	459	157	1.3	18	226	1.8	27
Gottingen, Germany	289	50	0.9	47	86	0.2	49
Number of Samples	6	6	6	6	6	4	6
Average	310.0	73.5	1.3	33.0	91.2	0.6	28.2
Standard Deviation	143.3	44.2	1.2	13.1	62.4	0.7	11.1
Maximum Value	537.0	157.1	4.0	47.0	226.3	1.8	49.0
Minimum Value	125.0	27.0	0.4	14.0	42.0	0.2	12.0

APPENDIX IX FECAL COLIFORM TESTING PROTOCOL

Ecology is recommending standard operating procedures for fecal coliform testing of compost samples in Washington State. Standard operating procedures are necessary for several reasons:

- o Standard Methods for the Examination of Water and Wastewater, 18th Ed. (SM18) does not address sample preparation of solid heterogenous materials as found in compost.

- o Variations in sample handling procedures, even when used with the same standard method, can have a dramatic effect on results of fecal coliform tests.

- o Jurisdictional health departments have requested standard operating procedures in order to compare data from different laboratories.

- o Ecology plans to generate a data base on fecal coliform analyses to aid in the development of future guidance on compost quality.

- o Standard operating procedures promote confidence in information from several different sources.

This standard operating procedure describes sample preparations and modifications of the multiple tube fermentation procedures in SM18 9221 B and E. The instructions are adapted from "Sludge Land Application Project: Microbial Procedures Manual", April 1982, a document published by King County Metro.

These instructions assume general laboratory cleanliness and sanitation of all glassware and equipment.

Sample preparation

1. Weigh out 50 grams of sample.

(Ecology note: weigh out a subsample at the same time and perform a total solids test per SM18 2540 G. This will enable lab results to be reported in dry weight.)

2a. Place 450 mls of *cold* APHA buffer containing 0.1 percent Tween 20 (a surfactant) in an industrial size blender and blend for one minute; OR

2b. Place 450 mls of *cold* APHA buffer containing 0.1 percent Tween 20 into a one quart sterile paint can and shake on the paint shaker for five minutes.

Dilution preparation

1. Prepare dilutions of the compost homogenate using dilution blanks with *cold* APHA buffer. Serial decimal dilutions should be done *immediately* to avoid settling, i.e. prepare dilutions in blanks *first* since subsequent dilutions will be based on these; then prepare 10 ml and 1 ml inoculant directly from the blender or paint can. Appropriate dilutions will be based on sample being processed and on previous data.

Total and Fecal Coliforms

1. Media (prepare according to manufacturer's directions):
   Lauryl Sulfate Broth
   Brilliant Green Bile Broth
   EC Broth with MUG

2. Inoculate five appropriate dilutions into lauryl sulfate broth fermentation tubes set up as a five-tube MPN.

3. Incubate for 48 hours at 35 degrees C.

4. At 24 and 48 hours, transfer positive lauryl sulfate tubes, using wooden applicator sticks to brilliant green bile broth (BGB) and EC broth with MUG. Record positive tubes on coliform MPN forms.

5. Incubate BGB tubes at 35 degrees C. Read and record positive results for turbidity and gas at 24 and 48 hours. This is a confirmation for total coliforms.

6. Incubate EC with MUG broth tubes at 44.5 degrees C in a water bath for 24 hours. Read and record positive tubes at 24 hours, only. Tubes with turbidity and gas are positive for fecal coliforms. Tubes with fluorescence under UV light are positive for E.coli.

   Incubation beyond 24 hours for this portion of the test will give false positive results.

7. Confirm one sample per set via the completed coliform tests, as described in Standard Methods, 18th Ed.

Reporting results

1. Report coliforms as MPN per 100 grams wet sample, <u>and</u>

2. Calculate results using total solids data to report as MPN per gram dry weight solids.